Chemical Published avery other Monday Engineering



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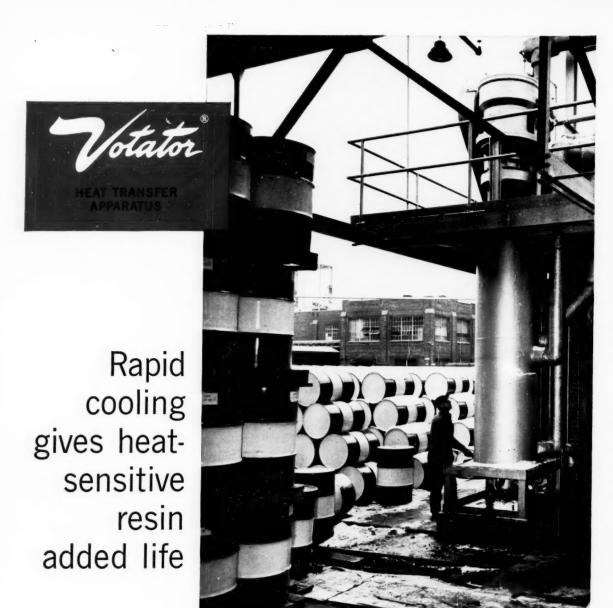
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New, fast, accurate way to ... Tube-Side Heat Transfer Coefficients

You Working for a Sma



New outdoor installation of VOTATOR Continuous Cooler at Bakelite Company, a Division of Union Carbide Corporation, Bound Brook, N. J.

AT BAKELITE COMPANY, another VOTATOR* Cooling Unit has recently been installed to increase output of their quality phenolic resins. The original equipment has been in constant use since 1946. In this application, function of VOTATOR Processing Apparatus is to prolong product life by rapidly cooling the resin prior to filling into drums, tank cars or storage tanks. As temperature drops, viscosity increases to more than 4000 cps. Output is 5,000 to 10,000 lbs. an hour.

Find out how you can improve your product and cut costs with Votator Heat Transfer Apparatus for continuous cooling, controling heat of reaction, emulsifying, crystallizing and sulfonation. Write for further information.



*VOTATOR-T.M.Reg U.S. Pat. Off.

JUNE 30, 1958

JOHN R. CALLAHAM, Editor-in-Chief

Gambill Series Wins Award

We always feel good whenever one of our favorite article series makes a hit with CE's readers.

And of course we feel even better if it also wins recognition in an editorial achievement contest.

That's just what's happened!

CE's popular series of articles by Wallace Gambill on "How to Estimate Engineering Properties" has just received an award of merit as one of the "best series of articles" in any industrial publication during 1957.

The contest, sponsored annually for the past 20 years by the well-known publication *Industrial Marketing*, is known as the Editorial Achievement Competition for Business Publications. This year there was a record number of entries—659—in the competition.

CE was one of seven industry magazines to win this year's awards for "best series" and the only chemical publication to receive a citation for editorial excellence in any of the contest's five categories.

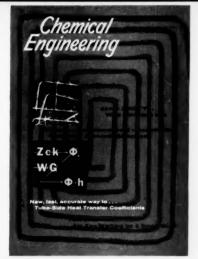
In fact, so far as we've been able to discover, this is the first time that this "highest award in business publication journalism" has been awarded to a chemical journal.

A panel of 12 industry marketing and advertising executives acted as judges to pick the winners in the industrial group.

Gambill's award-winning series on how to estimate engineering properties first appeared in CE's February 1957 issue.

You'll find his 17th installment—which completes his treatment of diffusion coefficients—on p. 113 of this issue.

Coming soon: a new series on viscosity determinations.



THIRTEENTH OF TWENTY-SIX ISSUES





How computers save research dollars by fast preliminary evaluations

At least one punched-card-and-tape computer is hard at work saving time and money for a group of research and development engineers. At Monsanto, their machine turns out preliminary economic evaluations and saves the tedious hours formerly needed to find out whether or not any particular line of research will pay off. (p. 99)



What materials to use above 2,500 F

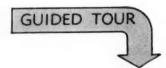
How new developments in theory and application of super-refractories are helping process technology toward new and more efficient reactions at temperatures well above 2,500 F. (p. 105)



Speedier heat exchange calculations

Brand-new charts give faster and more accurate answers. Heat exchanger design is

Chemical



easier with this trio of charts that find tubeside heat coefficients quickly and with very little math. (p. 110)



Are you working for smart bosses?

Here are 11 specific measures of management performance. How well does your company stack up? Are you investing your future in the right kind of company? How smart is your boss. (p. 119)



Lead-lined equipment at lower cost

Automatic lead cladding machine makes ducts for corrosive hot sulfur gases. It can be used in the field, costs far less than conventional methods of hand lead burning and bonding. (p. 122)



Three more ways to atomic power

Continuing CE's coverage of nuclear power, here are pictures and flowsheets of the newest atomic plants. Three different reactors, each with its own solution to the coolant problem. (p. 90)

CE is edited for the engineer concerned with chemical operations, whatever his function . . . administration, production and plant operations, design and construction, research and development, sales and purchasing. More engineers subscribe to CE than to any other magazine in the field. Print order this issue:

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Find heat-transfer coefficients-faster, easier...

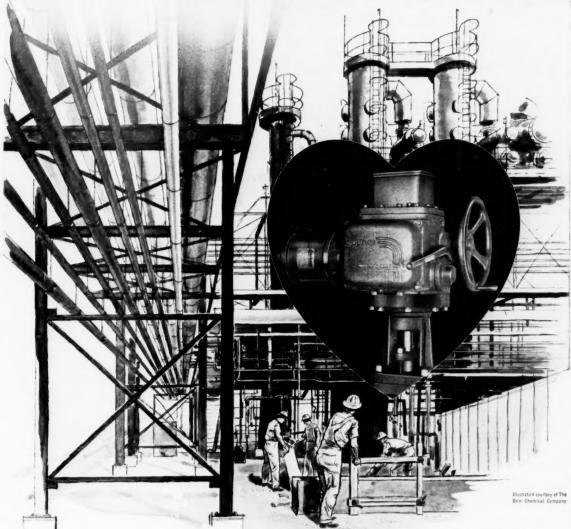
Your refinery's effluent is souring local streams. The fishing industry is fit to be tied and sportsmen aren't exactly mellowing over it either. Here's what to do.

With these charts you'll quickly find coefficients for petroleum fractions flowing inside tubes, within 5% of values you



proportional positioning

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LimiTorque converts any variable into a constant... Limitorque, the final control element, positively converts any up-stream process variable into a down-stream constant by continuously repositioning the control valve.

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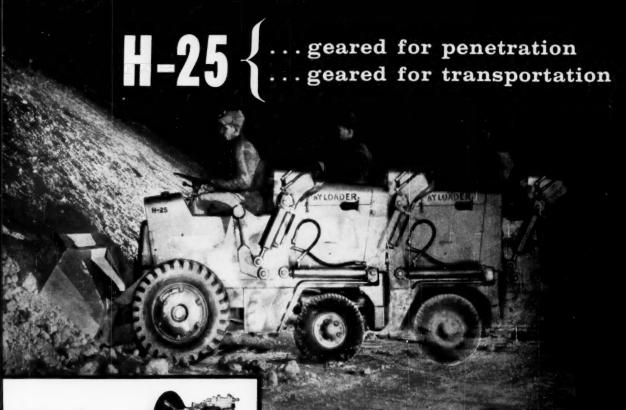
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THE FRANK G. HOUGH CO.

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Send full data on the H-25 PAYLOADER.

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Title.
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This new **PAYLOADER**° has more hustle than you've ever seen in a tractor-shovel. It's got everything to turn out big production all day long with the least operator effort and is the only machine in its class with *complete* power-shift transmission and power-steer. The carry capacity of 2,500 lbs. is 25% greater than has ever before been available in a tractor-shovel of its size and maneuverability, yet it easily goes in and out of boxcars with narrow 6-foot doors.

Another valuable and exclusive feature is the power-transfer differential that makes traction more effective and reliable at all times because the wheel with the better grip automatically gets the most power.

The H-25 is *full* of other plus features that mean more production, less maintenance and longer life: closed hydraulic system, wet-sleeve overhead valve engine, triple air cleaners, full-shift fuel capacity, 4,500 lbs. of bucket breakout force and 40° bucket tip-back, to mention only a few.

Your Hough Distributor wants to show you how the greater capacity, speed and handling ease of the H-25 can cut your bulk-handling costs. Ask him about Hough Purchase and Lease Plans too.



Modern Materials Handling Equipment

THE FRANK G. HOUGH CO.

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WILLIAMS ROLLER MILLS

 Quality Fine Grinding...
 20 Mesh To 400 Mesh...
 Micron Sizes On Some Materials

EXCLUSIVE GEARLESS AND SPUR GEAR DRIVES

Another Williams advancement! Cutaway shows Type D Mill with Spinner Air Separator with spur gear and pinion drive used on Standard and larger models. Smaller sizes have simple gearless V-belt drive which is easier to maintain than beyel gear drive—cuts labor and downtime.

Bearing alignment of central shaft is simplified with only 2 bearings, the bottom one carrying thrust as well as radical load.

NOTE FLOW OF MATERIAL being ground by rolls rotating against bull ring, then air-swept to separator which discharges finished product while returning coarse tailings for regrinding.

From raw material to finished product—completely automatic grinding, blending and precision classifying to 20 mesh or micron size!

Self-adjusting feed rate . . . instant adjustment for sizing, even while mill is in motion . . . continuous automatic take-up to compensate for wear . . . constant rising air current to prevent build-up of fines and inefficient operation . . . automatically controlled hot-air drying during grinding of moisture-carrying materials . . . all are features of Williams Roller Mills that virtually guarantee increased output, surprising cost reductions and exceptionally high uniform quality. Get all the facts immediately . . <u>Write today for catalog</u>.

WILLIAMS PATENT CRUSHER & PULVERIZER CO.



Hammer Mills

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Air Separators Vibrating

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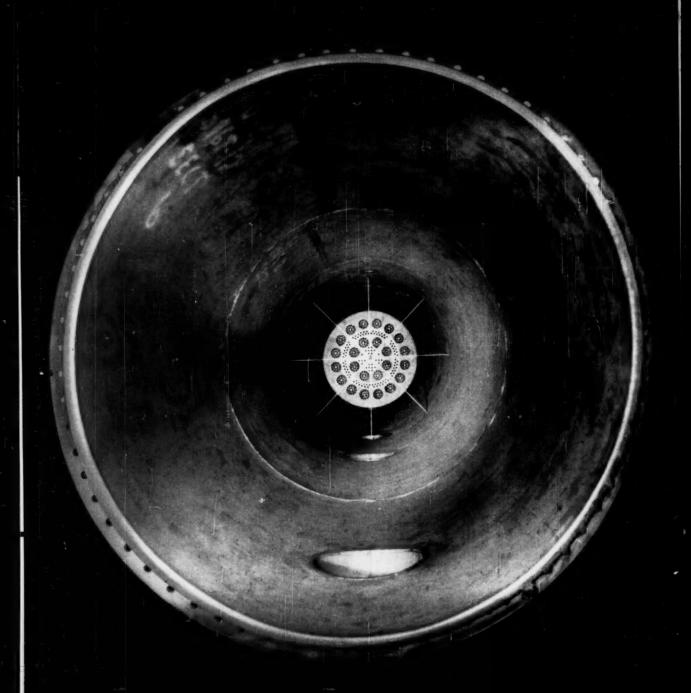
Impactors



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Working with Stainless Steel Is a Talent at ...



Vulcanmanufacturing



Copper...
was used in the fabrication
of these bubble cap type trays



Hastelloy . . . another unusual alloy was used to fabricate this high-pressure entrainment separator



Monel-clad, too! High-pressure reactor head of Monel-clad carbon steel

The fractionating tower shown at the left is one of thousands of process components fabricated in stainless steel by Vulcan Manufacturing since Vulcan built the first stainless steel equipment for the chemical industry in 1931. This fact is important to you in that it suggests an unusual depth of experience in working with a metal that has contributed so substantially to advances in process techniques. For example, Vulcan offers you reliable knowledge in the fabrication of stainless and stainless-clad as well as stainless lining or facing of carbon steel. We assure you of rigid quality control... use of the latest fabricating techniques... and the thorough testing of completed units.

It is this combination of skill and care in manufacture that has enabled Vulcan to become a leading producer of stainless steel components and to achieve a record output exceeding two million pounds of stainless steel equipment in 1957.

When your needs call for towers, heat exchangers or any vessel or part fabricated in any one of the 12 or more types of stainless steel—rely on the talent at Vulcan Manufacturing.



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Designers and builders of process equipment

DE LAVAL CENTRIFUGAL COMPRESSORS

used for light gas, in Magnolia

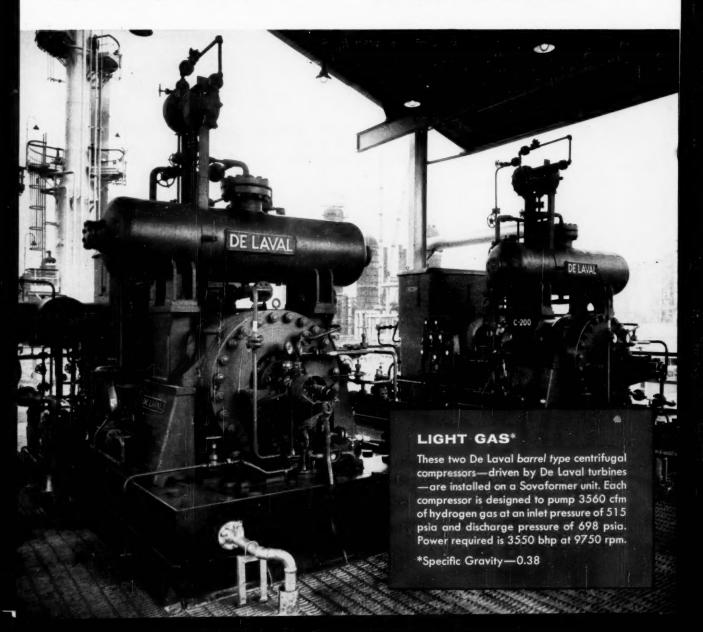
As part of the expansion program in the Beaumont, Texas refinery of the Magnolia Petroleum Company, De Laval turbine-driven centrifugal compressors are on stream in three important applications:

- recirculating hydrogen gas in a reforming unit
- pumping hydrocarbon gas in a compressor station
- . supplying combustion air on a giant cat cracker

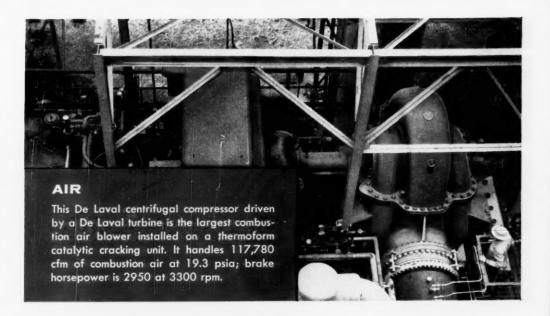
Designed and built to perform dependably in heavy-duty con-

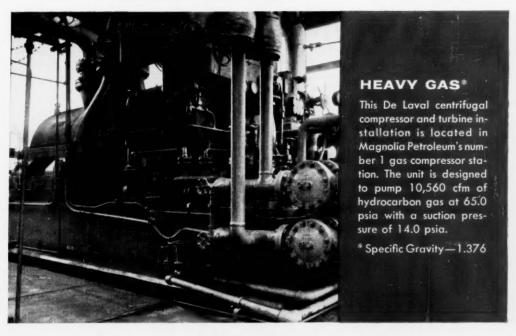
tinuous operation, De Laval centrifugal compressors are available for every refinery process. Whether you need to handle light or heavy gases at high or low pressures in catalytic cracking, reforming, alkylation, coking or any similar service, it pays to look to De Laval. We can give you the benefit of more than 40 years of experience in solving gas compression problems.

SEND FOR DE LAVAL BULLETIN 0504.



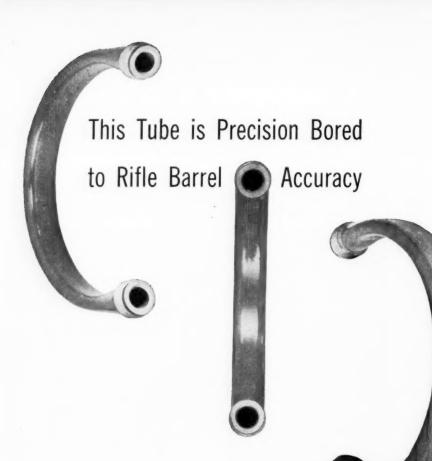
heavy gas and air handling Petroleum's expansion program







DE LAVAL STEAM TURBINE COMPANY 803 Nottingham Way, Trenton 2, New Jersey





Ashcroft Duragauge in Phenol case — a tough, rigid plastic turret type case for wall or flush mounting.

The Bourdon tube in Ashcroft Duragauges is machined mirror-smooth inside and finish ground outside to exact tolerances. Strong, uniformly thick walls assure precise flexibility—sustained high accuracy and long life.

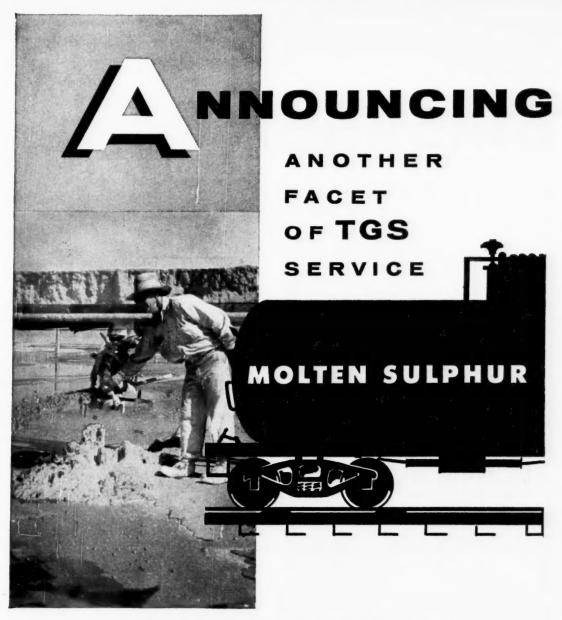
Eight tube materials permit you to select the best metal with sensitivity balanced by internal corrosion resistance. Whether your choice is phosphor bronze, an alloy steel, "K" Monel, a stainless steel or beryllium copper, metallurgical control is exact from ingot to finished tube. Socket and tip joints are welded or brazed, then stress relieved for highest strength and safety. "Whip testing" at pulsating pressures at least 50% greater than rated pressure insures calibration stability.

Order your Ashcroft Duragauges with the best Bourdon tube material for your service. Choose the all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. Full range of pressures, dial sizes, case designs and materials available. In any combination of components, Duragauges give sustained high accuracy and long service. Get details from your industrial supply distributor.



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KILNS · COOLERS · DRYERS



Traylor Rotary Kiln

Traylor Rotary
Cooler

Traylor Rotary
Dryer

Hundreds of Traylor Rotary Kiln installations are in daily use in thermo processing operations throughout the world. The vast kiln designing experience of Traylor Engineers is reflected in the many advanced features found in Traylor Kilns. The shells are made of quality steel plate, automatically welded together, with the necessary bars at points of maximum stress. Full floating type riding rings, attached to the shells without bolts or rivets, are turned true and smoothly faced. Both the main gear and pinion are reversible for extra wear. These and many other features are available in a Traylor-made Kiln.

Traylor Coolers are made in 3 types: Conventional design—a straight flow unit, Diaphragm design—a cooler fitted with diaphragms to keep material well showered and propelled forward, Multiple Tube design—made in air cooled or water and air cooled type, keeps material from direct contact with the cooling air. Special coolers can be provided for special conditions.

Traylor Rotary Dryers employ the same construction features as Traylor Kilns and Coolers. Traylor builds Rotary Dryers of 2 types: Indirect Fired Dryers in 3 designs and Direct Fired Dryers in 2 designs. For more information on Traylor Kilns, Coolers or Dryers, write for Traylor Bulletin #1115.

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When you're looking for economies, talk with our engineers about precision analytical instruments for sulfuric acid production, ethylene product analysis, and many other chemical and petrochemical processes. You'll find that L&N not only supplies advanced electronic Speedomax® recorders, indicators and scanners, analyzer cell systems and electric and pneumatic control systems, but sound answers for instrumentation problems involving:

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Electrolytic Conductivity—for detection of condensate purity and control of some processes.

Thermal Conductivity—for binary and simple gas mixtures.

Gas Chromatography—with $Chromomax^{(g)}$ for analysis of process streams.

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Thomas Autometer.

For further information on L&N equipment for chemical, petroleum and allied industries, talk to the men at our nearest office, or write to Leeds and Northrup Co., 4916 Stenton Ave., Phila. 44, Penna.



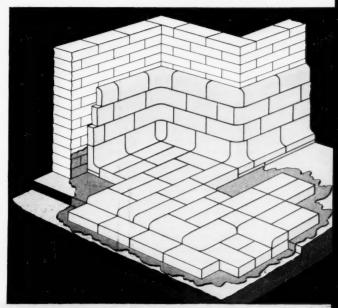
for durable, chemical-proof floors... HARBISON-WALKER

DURCID-PROOF ILE

Duro tile are dense and non-absorbent throughout their entire thickness and are not dependent upon a skin glaze for resistance to penetration by corrosive liquids. The smooth, non-glassy surface of Duro is good for traction and the avoidance of slippage. Surfaces can be textured if desired.

Duro is vitreous to the most desirable degree for high strength to withstand impact and abrasion and for maximum impermeability and resistance to chemical action. This combination of properties is attributable to its stabilized chemical composition of aluminum silicate which is exceedingly low in the more soluble basic fluxes, such as iron oxide and alkalies, the vacuum method of forming and the high temperature at which it is fired. Its mineral constituents are converted to the most stable forms of greatest insolubility in acids and various corrosive materials.

The light buff color of Duro, with freedom from the glare caused by glazed surfaces, contributes to the



9" x 4½" x 1½" ST

9" x 4½" x 2" ST

9" x 4½" x 3" ST 12" x 6" x 1½" ST

SHAPES AND SIZES Depicted here are typical designs of DURO floor tile constructions using Harbison-Walker shapes and standard rectangular sizes as shown.

clean, sanitary appearance of the floors. The excellent workmanship of Duro tile and the variety of cove base shapes makes readily feasible a neat close fitting construction that is easy to keep clean.

Typical applications for Duro floors

Acid Rooms Food Processing Plants

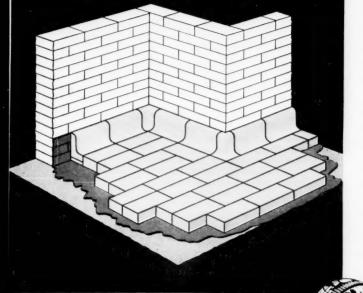
Acid Rooms
Bakeries
Bottling Plants
Breweries
Chemical Plants
Dairies
Die Works
Electroplating Plants
Electrolytic Metal

Refineries

Food Processing Plants
Galvanizing Departments
Meat Packing Plants
Metal Fabricating Plants
Paper Mills
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ZIRGONIUM

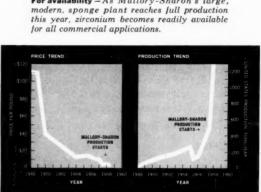
Now zirconium takes another giant step ... from an expensive rarity to a readily available special-purpose metal. Capacity is now on hand for not only A.E.C. requirements but also commercial markets. And, as in titanium, Mallory-Sharon is in the forefront of this rapid development.

A modern, highly efficient zirconium and titanium sponge plant at Ashtabula, Ohio, now makes Mallory-Sharon the largest single source of metallic zirconium, and its by-product, hafnium.

Mallory-Sharon's integrated production facilities ... from raw materials through finished mill products ... mean greater availability and lower costs.

We're ready now to help you explore practical commercial uses for zirconium. Write us for technical information, or engineering assistance on specific applications.

For availability - As Mallory-Sharon's large, modern, sponge plant reaches full production this year, zirconium becomes readily available for all commercial applications.



For lower prices - Greater availability will definitely be reflected in lower prices. In many cases, the improved performance of zirconium parts much more than offsets their higher material cost.

See our 4-page ad in Chemical Engineering Catalog, Pages 1147-1150, for additional tech-

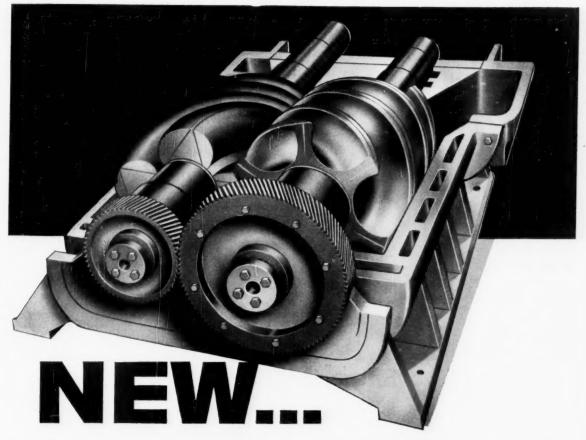


For technical facts - Write for new 16-page booklet, giving technical and application data on zirconium. its excellent corrosion resistance to most acids, alkalies and combinations of these media . . . its remarkable nuclear properties.









Fairbanks-Morse Positive Displacement Axial-Flow Rotary Compressor

Combines the best features of reciprocating and centrifugal compressors Consider the advantages of the all-new Fairbanks-Morse two-impeller, helical-lobe type, axial-flow rotary compressor:

- 1 Delivers oil-free air or gas with low ratios of unit weight and space to capacity.
- 2 Exhibits high efficiencies and positive-displacement stability of flow at varying compression ratios and speeds.

Result: Ideal performance from a relatively small compressor that is mechanically simple, flexible in application, adaptable to any power source; a compressor that provides stable performance, smooth operation, and variable-capacity control.

This all-new F-M Compressor is available in 5 standard case and impeller sizes, single-stage and multi-stage units—for pressure, vacuum or booster service. Capacities range from 800 to 13,000 cfm.—also higher or lower if desired, on custom-designed basis. Contact your Fairbanks-Morse branch for further information, or write directly to Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago 5, Illinois.



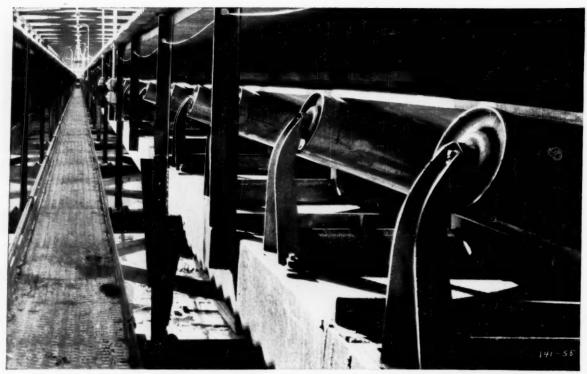
Ask for new illustrated bulletin ACO 100.1 giving typical performance characteristics and other important data.



FAIRBANKS-MORSE

a name worth remembering when you want the BEST

COMPRESSORS-ELECTRICAL MACHINERY-DIESEL AND DUAL FUEL ENGINES-DIESEL LOCOMOTIVES-RAIL CARS-PUMPS-SCALES-HOME WATER SERVICE EQUIPMENT-MAGNETOS



Automate your materials handling...

with Jeffrey equipment

Efficient, dependable Jeffrey conveying equipment is a valuable antidote for rising costs in processes where bulk materials must be moved. Permaseal.* idlers on these conveyors mean years of usage without greasing—contribute to lower operating and maintenance costs.

Jeffrey products are available through distributors in principal cities. You'll find these men *production-conscious*, ready and willing to advise on your conveying needs. For this help, see them or write The Jeffrey Manufacturing Company, 909 North Fourth Street, Columbus 16, Ohio.



Jeffrey spiral conveyors are available in many styles for moving dry, bulk materials. Compact, they occupy minimum space. Convenient, they can be fed or discharged at any point along their length.



Components of Jeffrey bucket elevators and other conveyors can be constructed to withstand corrosive attack, assuring long life and safeguarding materials handled.



For in-plant conveying or for belts extending across country, Jeffrey Permaseal.* idlers offer every feature essential to belt protection, dependability and long service.

CONVEYING • PROCESSING • MINING EQUIPMENT...TRANS-MISSION MACHINERY...CONTRACT MANUFACTURING





Surrounded by pressure tube problems?

LET TIMKEN COMPANY METALLURGISTS SELECT THE $\underline{\text{ONE}}$ STEEL ANALYSIS THAT GIVES YOU MAXIMUM TUBE LIFE PER DOLLAR.

You can use a good many high temperature steels to solve your particular pressure, temperature and corrosion problems. But only one steel analysis can give you longest tube life per dollar.

Timken Company metallurgists can find that exact analysis for you. They're specialists, recognized experts in high temperature steels. They can draw on more than 25 years of research and experience. Work for you the same way they have in solving hundreds of tough pressure tube problems for others, economically.

And we have the steels to do the jobs. They're available in all stainless and alloy grades to meet practically any combination of pressure, temperature and corrosion conditions. And you can get Timken seamless pressure tubes in sizes up to 11" O.D. x 3" wall. Accurate analysis is assured because we make only electric furnace fine alloy steel. It's always uniform—heat to heat, order to order, tube to tube.

For the money-saving answer to your pressure tube problems, call upon Timken Company metallurgists. The Timken Roller Bearing Company, Steel & Tube Division, Canton 6, Ohio. Cable: "TIMROSCO".

TIMBER Fine STEEL

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING

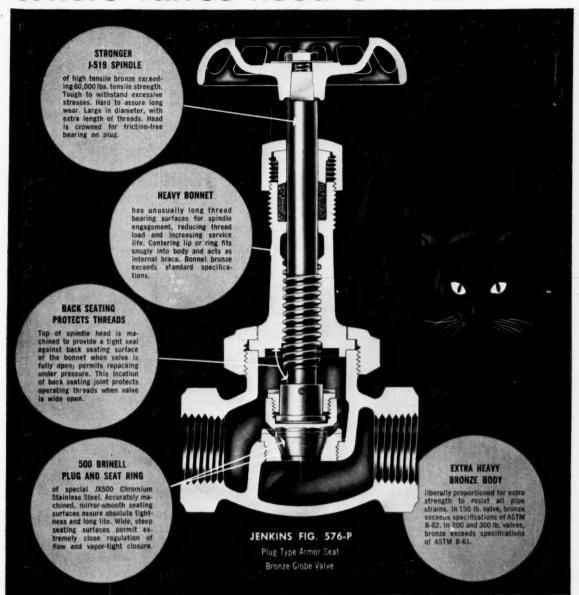
Fast Delivery of Sola-Flex® Expansion Joints...cuts costly down time!

Proven, dependable Sola-Flex Joints can be "in service" one to four weeks after receipt of order!

In power or processing plants, failure of a single expansion joint can mean slower production, expensive repairs, even complete shutdown. That's why, when faced with possible trouble, you want replacement joints fast! And you want joints that will protect against future unscheduled down time. Solar makes the world's most complete line of expansion joints. They are made in a wide variety of stainless and high alloys, are available in a complete range of sizes and styles, withstand difficult extremes of temperature and pressure. Best of all, rugged Sola-Flex joints can be "in service" in one to four weeks . . . or less! For a new Sola-Flex catalog, write to Dept. F-35, Solar Aircraft Company, San Diego 12, Calif.



Where valves need 9 lives...



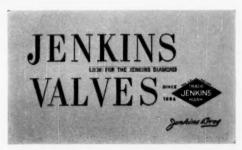
Install this JENKINS...made to defeat valve-killers

HERE are just five of the eighteen ways by which Jenkins Plug Type Valves have been engineered for maximum wear in valve-killing services. For any close-control steam service like drains, bypass lines, drips, blowoff, throttling, bleeders . . .

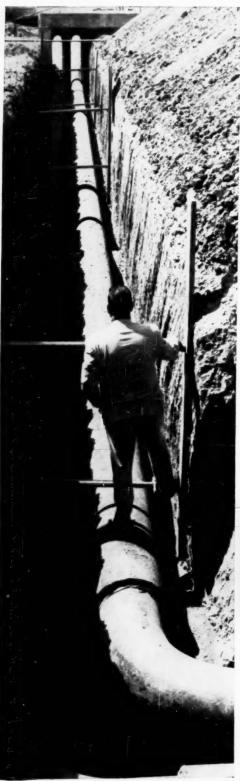
Or where abrasion, entrapped pipe chips, scale or rust tubercles are a problem . . .

You'll cut maintenance and replacement costs by specifying "Jenkins Plug Type, with the 500 Brinell Stainless Steel Armor Seat". In the Jenkins Catalog are 150 lb., 200 lb. and 300 lb., Globe and Angle, screwed or flanged end valves in a full range of sizes. And, they are available quickly from local distributors' stocks.

WRITE us, or ask your Jenkins distributor for descriptive folder No. 202-A. Jenkins Bros., 100 Park Avenue, New York 17.



Sold Through Plumbing-Heating and Industrial Distributors



IBM buried its piping problems and saved 50% on installationthanks to FOAMGLAS insulation

FOAMGLAS insulation makes installing underground piping simpler, less costly. Here's a case in point.

International Business Machines Corporation buried over 7,000 feet of chilled water piping-part of the central air conditioning system at its new San Jose, California, plant. Insulating the piping with Pittsburgh Corning's moistureproof FOAMGLAS—the unique cellular glass insulationcut their installation costs in half. Here's how.

Because it is completely impervious to ground water and soil acids, FOAMGLAS will maintain its original insulating value . . . protecting IBM's steel pipe against corrosion. This fact made direct burial of the insulated pipe practical. There was no need for a costly protective concrete tunnel or a presealed conduit to house the pipe. Either would have boosted installation costs from 200% to 300%. FOAMGLAS eliminated this extra cost.

FOAMGLAS is the most dependable—and often the least costly-solution to your insulation problems . . . for exposed or buried piping, equipment and plant structures. Write for complete information in our latest industrial catalog.

PC Glass Blocks are another outstanding building product of Pittsburgh Corning Corporation.

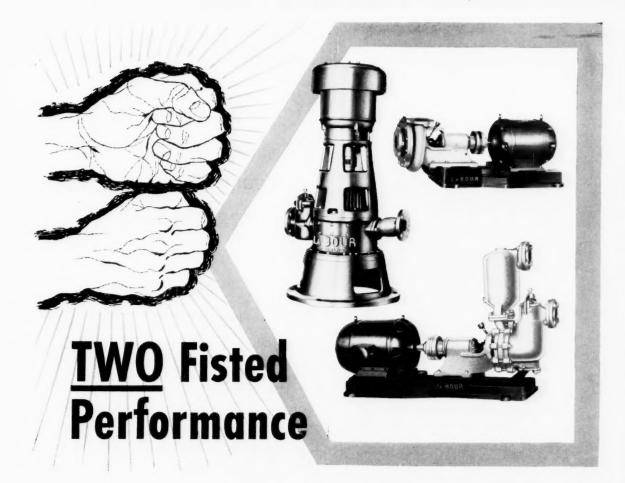


Above ground FOAMGLAS insulation insures constant thermal efficiency on IBM's chilled water lines.

Below ground piping gets two-in-one protection-against heat gain and against corrosion-from the sealed glass cells of FOAMGLAS.

PITTSBURGH CORNING CORPORATION

Dept. H-68, One Gateway Center, Pittsburgh 22, Pa. In Canada: 57 Bloor Street West, Toronto, Ontario



In pumping chemicals, maximum service satisfaction is dependent on *two* factors. Design and construction quality constitute one factor; the other is the accuracy of the foundry in meeting metallurgical specifications for corrosion resistance.

Because LaBour pumps embody such important and exclusive features of design it is perhaps easy to overlook the fact that LaBour foundries employ equipment and techniques second to none for precise control of alloy composition and grain structure.

That's why, when you buy LaBour, you get two-fisted performance assurance. Top ability to resist corrosion and top ability to move liquids economically and dependably are combined in these pumps. Ask for Bulletin B-lb.

REGULAR PRODUCTION IN LaBOUR FOUNDRIES INCLUDES THESE ALLOYS:

Electric Furnace Cast Iron

Bronze Lead

Aluminum

R-55 (Chrome-Nickel)

Y-17 (Chrome-Nickel-Molybdenum)

Y-30 (Nickel-Molybdenum)

149 Stainless Steel

304 Stainless Steel

316 Stainless Steel

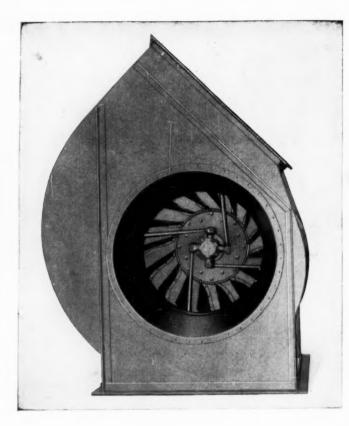
Elcomet K (High Nickel Stainless)

ORIGINAL MANUFACTURERS OF THE SELF PRIMING CENTRIFUGAL PUMP

LABOUR

THE LaBOUR COMPANY, INC. . ELKHART, INDIANA, U.S.A.





CORROSIVE GASES HANDLED WITH LESS MAINTENANCE LESS DOWNTIME

"BUFFALO" RUBBER-LINED FANS

- Longer Fan Life Proved in hundreds of installations over a period of more than 30 years, actual records show that up to 12 times the life of ordinary metal fans may be expected from "Buffalo" Rubber-Lined Fans in severe corrosive fume service. Thus you will spend very little time maintaining the "Buffalo" equipped system in your plant.
- Economies effected in the reduction of downtime are equally impressive. The overall savings of longer life plus decreased downtime pay the slight additional cost of rubber lining many times over. A fact executive management can readily appreciate.

The "Buffalo" method of rubber-lining assures permanence. The rubber is actually "welded" into the pores of the metal with a union that is practically integral. With the "Buffalo" Rubber-Lined Fan, corrosive fumes cannot touch metalthe inside of housing, rotor and shaft are completely rubberprotected.

Whatever your corrosive fume handling problem, your nearby "Buffalo" Engineering Representative will recommend the type of "Buffalo" Rubber-Lined Fan best suited to your requirements. Contact him, or write us for Bulletin 2424-F.

OTHER SPECIAL "BUFFALO" FANS FOR SPECIAL CONDITIONS - If you have a special air or materials handling job involving severe conditions ranging from corrosive fumes to abrasive dust, investigate "Buffalo" Resin-Bonded Fiber Glass Fans... Industrial Exhausters ... Volume Fans... Pressure Blowers and Centrifugal Exhausters... Electric Blowers and Exhausters.

Every "Buffalo" product features the famous "Q" Factor - the built-in QUALITY that provides trouble-free satisfaction and long life.

BUFFALO FORGE COMPANY

BUFFALO. NEW YORK

BUFFALO PUMPS DIVISION, BUFFALO, N.Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.



VENTILATING AIR CLEANING

AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING

HEATING

June 30, 1958—CHEMICAL ENGINEERING

PRESSURE BLOWING

"Used many makes of turbines... PREFERS COPPUS"

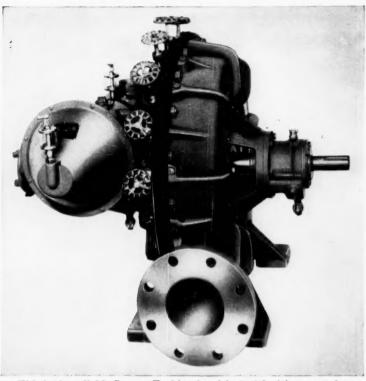
If you want to know about turbine performance, ask an *operator*. He *knows*. And, in the words of one of them:

"I have had occasion in the past to operate many makes of turbines. The plant in which I am now employed is almost entirely Coppus equipped on our auxiliary equipment. I find your turbines most satisfactory and would like to congratulate you on your design."

Whether you use a Coppus with a regular wheel or wide bucket "L" type you get these proven features:

- Turbines rated close to your hp requirements from 150 hp down to fractional. No need to buy a bigger, costlier turbine than your conditions call for.
- A larger number of steam nozzles, controlled individually by manually operated valves.
- Exclusive pilot operated excess speed safety trip supplementing constant speed governor.
- Replaceable cartridge type bearing housings.
- Optional carbon ring packing glands.
- Coppus Steam Turbines ranging from 150 hp down to fractional in 6 frame sizes, make turbine dollars go farther. Send for Bulletin 135 on Coppus Turbine.

COPPUS ENGINEERING CORPORATION 227 Park Avenue, Worcester 2, Mass. Sales offices in THOMAS' REGISTER



This is the reliable Coppus Turbine furnished with either a regular wheel or wide bucket "L" type wheel.



This wide bucket "L" type wheel is a new development for use where low water rate is essential



This is the regular wheel used on Coppus Turbines which have been so highly satisfactory throughout industry.

COPPIS TURING



GET THE MOST FOR YOUR

BTU DOLLAR

...with Nicholson steam traps

You get top operating temperature per dollar of fuel consumption . . . when you use the Nicholson steam trap. This trap purges all air and non-condensibles from pipes and equipment continuously . . . not just at warm-up time. Your boiler doesn't have to operate at top capacity -all the time-to obtain top steam temperature where and when you need it.

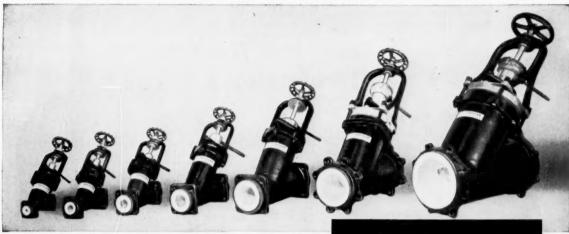
Make full use of your BTU dollar, with

Nicholson traps. They have only one moving part . . . a valve that operates on just a few degrees of temperature differential.

In your steam generation, and in your steam utilization . . . Nicholson traps will save you money. You can try one . . . without obligation! W. H. Nicholson and Company, 12 Oregon St., Wilkes-Barre, Pa. Sales and Engineering Offices in 98 principal cities.



of Wilkes-Barre



LOW-COST SECURITY FOR YOUR CHEMICAL LINES...



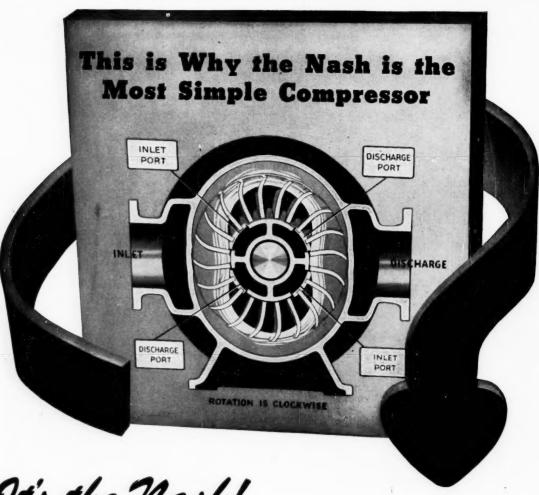
LAPP SOLID PORCELAIN VALVES WITH TUFCLAD®ARMOR

Install Lapp Solid Porcelain acid proof valves and have that trouble-free chemical line you want—at a cost well within budget. With Lapp Valves in your system, you have the assurance of purity, protection and permanence.

Because of its many special characteristics, Lapp Chemical Porcelain is the *ideal material* for maintaining *strict purity*. It is chemically inert, therefore resistant to corrosion from acids of all concentrations (except hydrofluoric); it's hard, dense, pure, homogeneous, close-grained and non-porous. Impregnated and bonded to this porcelain by an Epoxy resin of high strength and chemical resistance is an armor consisting of multiple layers of strong fiberglass. This serves as an insulator against thermal shock, a cushion to accidental impact and is strong enough to hold operating pressure even if porcelain is fractured. Built-in seating handle, solid Teflon packing, spring washers, malleable iron trim and brass stud and bushing are other advantages that make Lapp Valves well worth your investigation.



WRITE for description and specifications. Lapp Insulator Co., Inc., Process Equipment Division, 2201 Chestnut St., LeRoy, N. Y.



It's the Nash!

There are no mechanical complications in a Nash Compressor. A single moving element, a round rotor, with shrouded blades, forming a series of buckets, revolves freely in an elliptical casing containing any low viscosity liquid. This liquid, carried with the rotor, follows the elliptical contour of the casing.

The moving liquid therefore recedes from the rotor buckets at the wide part of the ellipse, permitting the buckets to fill with gas from the stationary Inlet Ports. As the casing narrows, the liquid is forced back into the rotor buckets, compressing the gas, and delivering it through the fixed Outlet Ports.

Nash Compressors produce 75 lbs pressure in a single stage, with capacities to 6 million cu. It. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

Nash simplicity means low maintenance cost, with original pump performance constant over long periods. Data on these pumps sent immediately on request No internal wearing parts.

No valves, pistons, or vanes.

No internal lubrication.

Low maintenance cost.

Saves floor space.

Desired delivery temperature automatically maintained.

Slugs of liquid entering pump will do no harm.

75 pounds in a single stage.

NASH ENGINEERING COMPANY
313 WILSON, SO. NORWALK, CONN.



WOLVERINE MAKES ALL THESE TUBES



...FOR HEAT EXCHANGE ...FOR CONDENSING

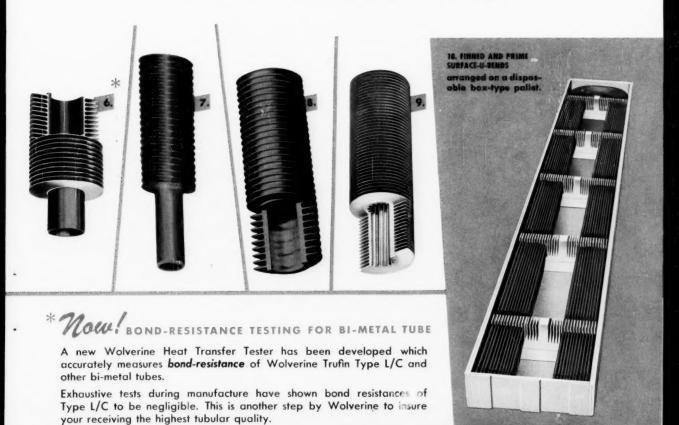
- 1. PRIME SURFACE TUBE
- 2. WOLVERINE TRUFIN TYPE S/T
- 3. WOLVERINE TRUFIN TYPE W/H
- 4. PRIME SURFACE TUBE-Bi-Metal

- 5. WOLVERINE TRUFIN-Bi-Metal
- 6. WOLVERINE TRUFIN TYPE L/C-Bi-Metal
- 7. WOLVERINE TRUFIN TYPE H/R
- 8. WOLVERINE TRUFIN TYPE H/A
- 9. WOLVERINE TRUFIN TYPE I/L

Wolverine Tube believes that to serve an industry well you must know its problems. That's why it maintains an extensive research and development program—from which has come the wide range of heat exchanger tubes illustrated below. From these you can choose

tubing that will successfully withstand corrosive attack . . . boost heat transfer capacity . . . or eliminate (with U-Bend tubes) the fabrication and handling problems encountered when working with condenser tubes over 30 feet in length. Any one you specify will serve you well.

Wolverine Trufin is available in Canada through the Unifin Tube Division, London, Ontario.



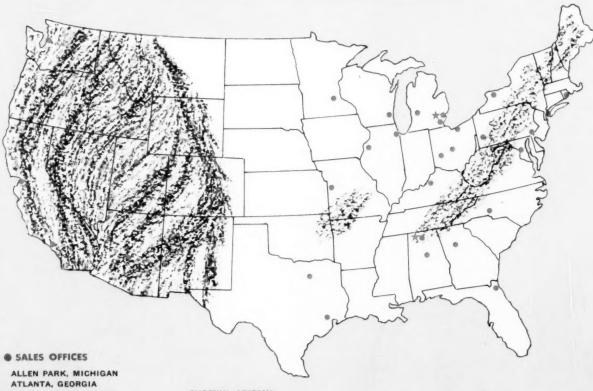


FREE ENGINEERING HELP

Skilled engineering help-from men who know tubing and how it can serve you most advantageously—is instantly available to Wolverine customers. If you have a problem concerning heat transfer, corrosion, type of tube to use or what have you-don't hesitate-just call on Wolverine's Field Engineering Service. There is no obligation.

AS NEAR AS YOUR TELEPHONE

Wolverine sales offices are maintained in many cities throughout the United States. You'll find the names and addresses listed in the yellow pages of your telephone directory.



BIRMINGHAM, ALABAMA CHARLOTTE, NORTH CAROLINA CLEVELAND, OHIO COLUMBUS, OHIO DALLAS, TEXAS DAYTON, OHIO DECATUR, ALABAMA DENVER, COLORADO DETROIT, MICHIGAN EVANSTON, ILLINOIS GRAND RAPIDS, MICHIGAN HOUSTON, TEXAS JACKSONVILLE BEACH, FLORIDA KANSAS CITY, MISSOURI LOUISVILLE, KENTUCKY LOS ANGELES, CALIFORNIA MILWAUKEE, WISCONSIN MINNEAPOLIS, MINNESOTA MOLINE, ILLINOIS NEW YORK, NEW YORK PITTSBURGH, PENNSYLVANIA PHILADELPHIA, PENNSYLVANIA

PHOENIX, ARIZONA PROVIDENCE, RHODE ISLAND ROCHESTER, NEW YORK SALT LAKE CITY, UTAH SAN FRANCISCO, CALIFORNIA ST. LOUIS, MISSOURI

* WOLVERINE PLANTS DETROIT, MICHIGAN



Cooper-Bessemer JM Compressors



keeping costs low, efficiency high at Sohio Chemical

COMPRESSION, of course, plays a key part in the fertilizer and dry ice plants of Sohio Chemical at Lima, Ohio.

Here, where CO₂ compression runs to 2800 psi, and inlet temperatures as low as 50 F often occur, Cooper-Bessemer motor-driven M-Line compressors live with such severe requirements effectively and economically . . . month in, month out.

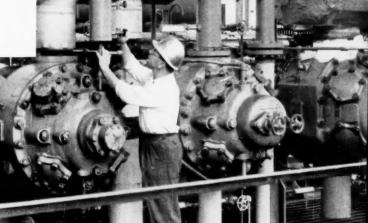
One of these units is a 6-cylinder JM rated 1250 hp

at 300 rpm, handling the compression of CO₂ to 1200 psi for the forming of dry ice cakes and handling NH₃ for storage refrigeration. The second, also motor-driven, is a 4-cylinder JM rated 1250 hp at 300 rpm. This unit, compressing CO₂ for UREA production, handles pressures up to 2800 psi.

Both compressors boast an enviable record of dependability regardless of demands or operating conditions. Make sure your files contain complete information. Write today.



With this Cooper-Bessemer JM6... efficient operation under adverse conditions of low inlet temperatures.



In the Lima, Ohio plant of Sohio Chemical this IM compressor handles CO2 compression to 2800 psi.

BRANCH OFFICES: Grove City • New York • Chicago Washington • San Francisco • Los Angeles • Houston Dallas • Odessa • Minneapolis • New Orleans • Shreveport

SUBSIDIARIES: COOPER-BESSEMER OF CANADA, LTD....
Edmonton • Calgary • Toronto • Halifax
COOPER-BESSEMER INTERNATIONAL CORPORATION ...
New York • Caracas • Mexico City

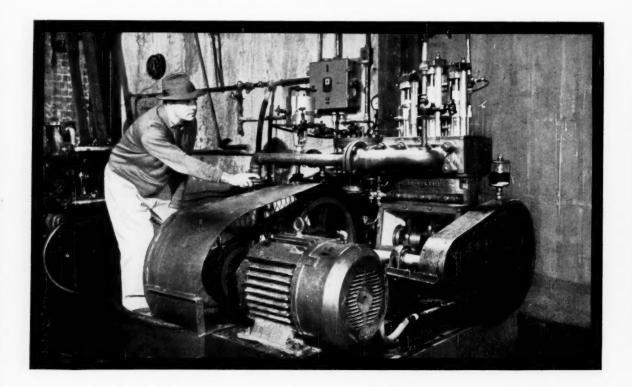
Cooper Bessemer

ENGINES: GAS - DIESEL - GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL,
ENGINE, MOTOR OR TURBINE DRIVEN

JACQUES WOLF & CO. SOLVES PROBLEM:

How to maintain constant, undeviating pressure in the production of highly corrosive chemicals

Precise, non-fluctuating pressures must be maintained in continuous processes at the Carlstadt plant of Jacques Wolf & Company. Erratic pressure caused by drop in volumetric efficiency could ruin an entire batch of costly material.



How Jacques Wolf solved the puzzle: Looking for an answer to the problem of holding constant pressure, plus that of increasing production, Jacques Wolf called on Aldrich. Aldrich engineers designed a pump which provided the proper corrosion resistance, fluid velocity and wear characteristics to insure dependable, continuous operation.

Result: After five months of use, the Aldrich Triplex Pump has met all guarantees and proven itself capable of continuous operation. Working 24 hour days, 6 day weeks, the Aldrich Triplex Pump provides the necessary pressure without fluctuation, efficiently handling both alkaline and acidic materials.

We'll be glad to send you full information on Aldrich Pumps and their advantages to you. Simply write Aldrich Pump Company, 3 Gordon Street, Allentown, Pa.

the toughest pumping problems go to





PHOTO COURTESY HELENA RUBENSTEIN, INC.

The Chemical Engineer keeps 83 million women beautiful

Soaps and perfumes, lipstick and cosmetics . . . more contributions to the better life made possible by the Chemical Engineer and his technology . . .

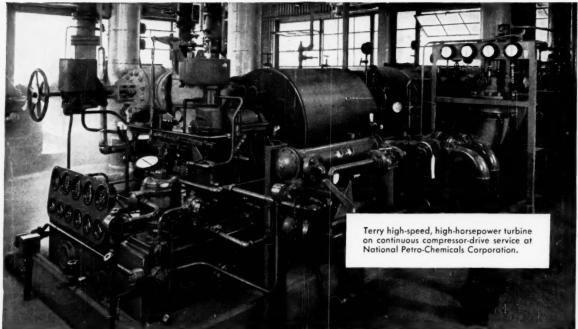
In industries using chemical processes and techniques . . . their products range from explosives to cosmetics . . . the one unifying influence is the active presence of the chemical engineer and his technology. These industries buy big . . . a third of all capital goods, \$46 billion in raw materials and fuels . . . and it's the chemical engineer who rec-



ommends and specifies as processing needs turn into orders. Sell him *first* and you've sold the common buying denominator of the Chemical Process Industries.

Only one magazine, Chemical Engineering, is aimed exclusively at the chemical engineer, whatever his function. And it's preferred by a solid 3 to 1 margin among chemical engineers in all functions, in all industries. This year you can talk to them with a greater frequency, timeliness and impact than ever before. Chemical Engineering, A McGraw-Hill Publication, 330 West 42nd St., New York 36, N. Y.

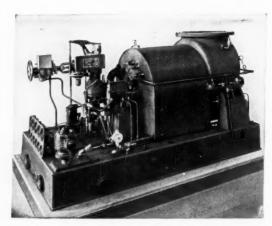
Published every other monday for Chemical Engineers in all functions



Hedrich-Blessing photo

At National Petro-Chemicals Corporation . . .

Terry high-speed compressor-drive turbines provide continuous 'round-the-clock service



One of the two 5400 hp., 7486 rpm turbines built for the Tuscola plant of National Petro-Chemicals Corporation.

In the fall of 1953, five Terry multistage turbines were placed on day-and-night duty at the Tuscola, Illinois, Plant of National Petro-Chemicals Corporation. They drive high-speed compressors used to compress hydrocarbon gases in the production of ethylene.

The excellent performance of these initial units later resulted in the installation of two more Terry machines. These were placed in service some two years later.

In all, the seven turbines total more than 30,000 hp. They range in capacity from 3300 to 5400 hp., and in speed from 7500 to 9700 rpm.

The National Petro-Chemicals installation, and the thousands of other units serving in refineries and chemical plants throughout the world, are testimony to the low maintenance and consistent reliability of Terry turbines. Put Terry to work for you. Write for further information.

THE TERRY STEAM TURBINE CO.

TERRY SQUARE, HARTFORD 1, CONN.



June 30, 1958—CHEMICAL ENGINEERING



Motor Operated for Remote Control



SOLD THROUGH DISTRIBUTORS IN EVERY MAJOR CITY

Can be supplied: wrench-operated; handwheel-operated; worm gear-operated. Adapted for remote control through use of electric, hydraulic or air motor.

For complete catalog information, write to Dept. A, Box 2592

WEDGEPLUG VALVE COMPANY

Division of

STOCKHAM VALVES & FITTINGS

GENERAL OFFICES AND PLANT • BIRMINGHAM 2, ALA.

CUT HIGH

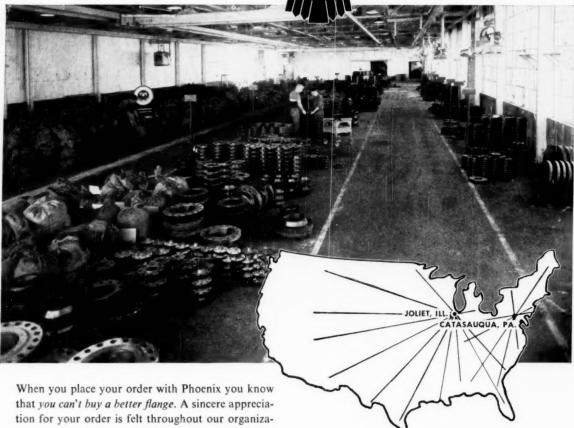
MAINTENANCE COSTInstall WEDGEPLUGS

- No Lubricants Required for absolute control.
 Plug Lifts, Turns and Reseats in one quick, easy operation.
- Non-Sticking—No field adjustment necessary for variable temperatures.
- Seats are Protected against valve-killing erosion of dry and fluid catalyst.
- Wedgeplugs Have Proven Themselves to be top performers on such services as hydrocarbon vapors at 900°F. and 600 psi; fluid catalyst at 1125°F. and 255 psi; and, hydrogen at 900°F. and 300 psi.

WEDGEPLUG NON-LUBRICATED STEEL PLUG VALVES

DESIGN ELIMINATES NEED FOR LUBRICATION

Is So Good! Why Service On



tion. To expedite your orders we have expanded and streamlined our warehouse facilities, as shown, to make Phoenix service even better. For your regular

requirements or special flanges in carbon or alloy steel, contact Phoenix and we'll show you what we mean.

Write for handy 36 page pocket-size reference booklet containing useful data on flanges.



IMMEDIATE SHIPMENT FROM TWO FACTORY WAREHOUSES

Conveniently located in the East near Philadelphia and Metropolitan New York and in the Midwest near Chicago, Phoenix factory warehouses at Catasauqua, Pa. and Joliet, Ill. are prepared to ship immediately regular types and sizes of quality Phoenix forged steel pipe flanges. That's why prompt delivery is assured—overnight to nearby points -in only a few days to distant points.

Leading Manufacturers of Pipe and Tank Flanges and Commercial Forgings



FLANGE AND FORGING DIVISION

PHOENIX MANUFACTURING COMPANY

CATASAUQUA, PA. . JOLIET, ILL. . FOUNDED 1882

Integrated Manufacturing Facilities: FLANGE AND FORGING DIVISION, STEEL MILL DIVISION, HORSESHOE PRODUCTS DIVISION, RUBBER PRODUCTS DIVISION

PERMUTIT® presents the

VALVELESS FILTER

Completely Automatic Gravity Filter Costs Less than Manual Unit

Uses no valves, no pumps, no flow controllers

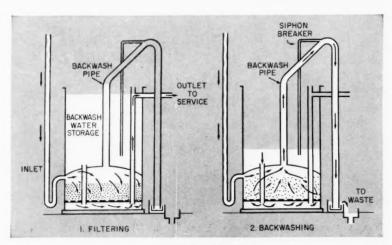
Here's an entirely new concept in water filters for cities, factories and power stations: a filter that *eliminates* operation and maintenance expense... yet costs *less* than a conventional manually-operated gravity filter of the same size.

The Permutit Valveless Filter can be used wherever gravity flow is feasible. Units are now in operation providing both plant process and drinking water.

FOOLPROOF OPERATION

The Valveless Filter thinks for itself. It starts backwashing at a predeter-

mined head loss, rinses and returns to service automatically . . . and as efficiently as an expertly operated manual filter. It assures uniform, high quality effluent because it eliminates "human error." It cannot be forced. It cannot backwash or rinse too soon or too late, too fast or too slow, too much or too little. It cannot develop a negative head and thus eliminates the chief cause of mudballs, channelling, upset beds. The absence of gravel eliminates another cause of upset beds. Backwash or rinse water cannot be accidentally run to service.



HOW IT WORKS

Filtering. Water enters at left, flows through sand, strainers and false bottom up effluent duct to service. As head loss increases during run, water rises in backwash pipe. At maximum headloss, water spills into downward section of backwash pipe and starts backwash (siphon) action.

Backwashing. Siphon draws water from storage down through ducts, up through strainers and sand to expand and wash bed, then to waste. At low storage level, air enters siphon breaker to stop backwash. Flow reverses and filtered (rinse) water flows into storage until full. All flow then goes to service.



PROVEN PERFORMANCE

Photo shows two Valveless Filters in a large industrial plant. (Shut-off valve at left is used only to take front filter out of service.)

LOW INSTALLATION AND EXPANSION COST

Filters up to 10 ft. diameter are shipped set up. Piping is simple. Future filters are easy to add since they require no additional backwash water storage or pump capacity. Filters use minimum floor space.

FREE BULLETIN

New bulletin, "The Permutit Valveless Filter," includes details, drawings, operating conditions, capacities. Address: The Permutit Company, Dept. CE 6, 330 West 42nd St., New York 36, N. Y. or Permutit Company of Canada Ltd., Toronto 1, Ont.

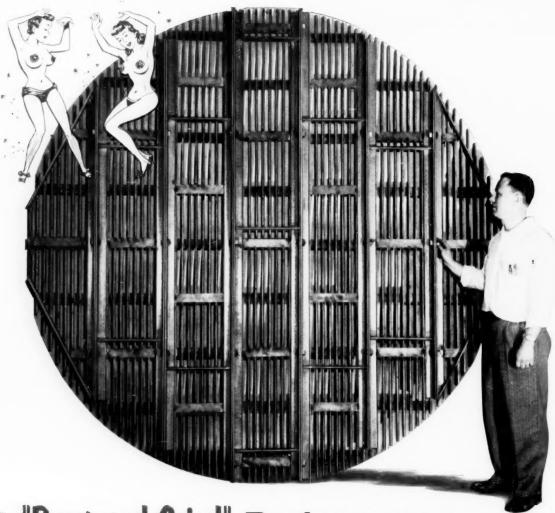
PERMUTIT.

rhymes with "compute it"

A DIVISION OF PFAUDLER PERMUTIT INC.

Water Conditioning

Water Conditioning Ion Exchange • Industrial Waste Treatment



A "Bump and Grind" Performance ... you can do without!

tower it's a headache to all concerned.

Even a hard-boiled chemical engineer can get a kick out of a good "bump and grind" performance on the stage. But when it happens in a

Movement in a packed bed can be brought about by a number of things: a pulsating gas stream, vibration of the tower, or the tendency to operate a tower as close to the flooding limit as possible. Whatever the cause, unless some means is provided to confine the packed bed, the continuous "bump and grind" will destroy the packing.

U. S. Stoneware offers a simple solution to the problem: a floating "hold down" plate which rests on top of the packed bed and whose weight holds the packing in place. U. S. Stoneware hold down plates* are made to fit any size tower in a variety of weights ranging from 10 lbs. to 50 lbs. per square foot. They are available in ceramic, in mild steel, stainless steel or copper.

*Patent applied for

For full details on U. S. Stoneware's "hold down" plates, write for Bulletin HDP-56.

U. S. STONEWARE

215-F

Chemical Engineering

Developments

JUNE 30, 1958

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This plant turns out electrode-grade carbon from petroleum coke; could make same product from coal-tar coke if low-temperature coal carbonization eventually goes commercial.	
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Polaroid snapshots combine speed and permanence in chart- ing crystallization. Thus, they help operators control growth to guarantee a uniform crop of crystals.	
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Metal supply and demand: No shortages today	78
For the first time since the start of the defense buildup prior to World War II, a period of nearly 20 years, all major metals are in adequate supply—and then some.	

Coming next issue: Plastics race grows hotter

All along, plastics have been eyed mainly for specialty products. Now, though, they're looming large as basic materials for big structural projects.



Leading cosmetics maker reduces blending, discharging and cleaning time eliminates batch contamination and dust condition

Germaine Monteil solves series of blending problems with P-K "Liquid-Solids" Blender

A conventional mixer used for the production of their famous dusting powders was costing Germaine Monteil valuable production time. Blending required 3 hours; discharging. ½ hr.; cleaning, over 2 hours (after which a residual odor still remained). In addition the mixer caused a hazardous dust problem during charging, blending and discharging.

Then a P-K Liquid-Solids Blender was installed . . . with these results: Blending time has dropped to fifteen minutes; discharging time has been reduced to less than five minutes; cleaning time has been cut to a few minutes, because the satin smooth shell interior has no baffles or inaccessible pockets. All these accraed savings in time permit production men to perform other functions, thereby saving manpower.

Equally important to Germaine Monteil is that the P-K unit can be clinically cleaned between batches—no residual odors remain to contaminate the formulations. The hazardous dust problem has also been eliminated due to the exclusive P-K seals and dust-tight covers.

Furthermore, product quality is excellent — results to date show that oil and perfume blend far better in the P-K "Liquid-Solids" Blender than any other type of mixer previously used. (The perfume essence was 1/4th of an ounce to 100 lbs. of bulk material.)

Prove these benefits yourself at P-K's Customer Service Lab

P-K can help you determine accurately the right type of "Twin-Shell" Blender for your needs. Complete lab facilities are available for blending materials from 4 qts. to 5 cubic feet (working capacities). Comparison tests can be made on the spot. You and your staff can conduct your own blending studies . . . or P-K's qualified blender technicians will help you make them. If it's impractical for you to conduct these tests personally, arrangements can be made to send us your formulations for testing. In either case, write or call Russell Dotter at P-K.

For technical data on P-K "Twin-Shell" Blenders for production or laboratory use, write for bulletins 15a-1 (lab) or 15 (production). The Patterson-Kelley Co., Inc., 1506 Hanson Street, East Stroudsburg, Pa.

All P-K "Twin-Shell" Blenders are patented and the name registered.

Patterson

Kelley

P-K Twin Shell Blenders • Heat Exchangers • Packaged Pilot Plants • P-K Lever-Lock Doors • P-K Vacuum Dryer Blenders

June 30, 1958—CHEMICAL ENGINEERING

Chementator

C. H. CHILTON

Steam-hydrocarbon reforming in a fluid bed of nickel catalyst will feature the third in Britain's series of projected hydrogenation plants for manufactured gas. In conventional reformers for making hydrogen, catalyst bed is fixed.

Add to trade-secret hassles:
Consent decree just entered in Newark District
Court restrains Dixon
Chemical and four former
employees of Allied Chemical from using Allied's
trade secrets relating to
manufacture of alum and
HF and regeneration of
sludge acid.

First water desalting plant to serve an incorporated municipality will use an Ionics electrodialysis unit to purify 28,000 gal./day of brackish well water. Pioneer community is Coalinga, Calif.

Research jobs are not recession-proof, it seems. Kaiser Aluminum, for example, has cut its metallurgical research staff at Trentwood, Wash., from 140 down to 80 in past two months.

How long can know-how be protected?

An employer who requires engineers to sign long-term contracts restricting their future activities may be inviting charges of monopoly.

Case in point is Chas. Pfizer & Co. Late last month the Justice Dept. brought suit in U. S. District Court (Eastern District of New York), charging Pfizer with monopolistic practices in the manufacture and sale of citric acid. (Pfizer does 90% of U. S. citric acid business).

Four of the six allegations concern business conduct, but the other two directly involve the work of engineers. According to the complaint, the defendant:

 Restricts each employee, via a mandatory contract, from engaging in the manufacture of citric acid for a period of ten years after termination of his employment.

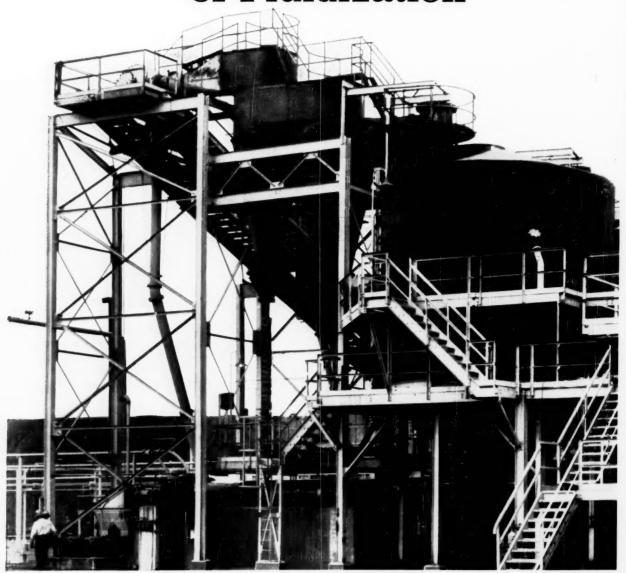
 Restricts an individual or firm who does outside engineering work on citric acid facilities for Pfizer from doing engineering work on citric acid for anyone else for a similar period of ten years.

Pfizer President John McKeen explains that these agreements merely "contain the clauses customary in industry to protect trade secrets." Apparently reinforcing his viewpoint is the recent court decision (Chementator, June 2, p. 43) upholding Monsanto's employee contract as a valid instrument for guarding technical know-how.

However, the Attorney General does not charge that such agreements per se are illegal. He alleges, rather, that Pfizer has used extralong-term contracts (Monsanto's contract holds for only three years) as one of several means of acquiring and maintaining an illegal monopoly. And legal means to an illegal end have regularly been condemned under the antitrust laws.

The Government asks the court to adjudge Pfizer's employment and engineering contracts pertaining to citric acid manufacture to be in violation of the Sherman and Clayton

More proof of versatility of Fluidization

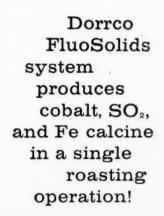


What is Fluidization?

A valuable new tool for the mining and process industries. When particles are suspended in an upwardly moving stream of gas, the entire dense mass behaves much like a liquid and is said to be fluidized. Applied in the Dorrco fluid bed reactor, fluidization results in a new and more efficient roasting technique, in which each particle of material is individually surrounded by a film of air or gas supplied by an external blower. A combina-

tion of reactor, cyclones and other auxiliary equipment forms a complete processing system, adaptable to a wide range of applications.

HELP FOR YOUR PROBLEM: If there's a step in your process where intimate contact between solids and gases is required, fluidization should be investigated. Dorr-Oliver will be glad to work with your research and development men, run pilot plant tests at our laboratories, or cooperate in any other way to insure a realistic evaluation in terms of your particular needs.



Installed and in operation since 1952 primarily for production of SO₂ gas for acid making and a calcine for iron manufacture, the Dorrco FluoSolids system at a well known East Coast steel mill gives new proof of the versatility of fluidizing techniques.

Pyrite received by the mill from one source of supply has a valuable cobalt content. A single roasting operation not only promotes preferential cobalt sulfatization that results in an average 90 percent cobalt extraction with weak acid at the leaching plant, but also produces SO₂ in sufficient strength for sulfuric acid manufacture, as well as calcines for blast furnace charging. The success of this operation, never before attempted in commercial practice, is an outstanding example of the many processing opportunities offered by the Dorroo FluoSolids system.

The installation at this plant consists of three 18' diam. reactors with pulping and holding tanks, cyclones and other auxiliary equipment. Currently one reactor is used to handle

the cobalt-bearing concentrate.

Applications of the Dorrco FluoSolids system in other industries include arsenopyrite gold roasting, zinc concentrate roasting, providing a sulfating roast for copper-zinc concentrates, roasting sulfides for making cooking liquor in sulfite paper mills, and limestone calcination.

If you'd like more information on this significant advance in roasting techniques, write to Dorr-Oliver Incorporated, Stamford, Connecticut.

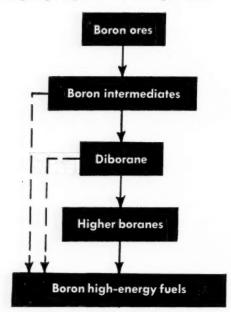


Dorrco and FluoSolids are trademarks of Dorr-Oliver Incorporated. Reg. U.S. Pat. Off.



Acts and that Pfizer be prohibited from enforcing such contracts. The Government also seeks to force Pfizer into sharing its citric acid knowhow with other manufacturers.

Bright prospects for new jet fuels



Will the new high-energy fuels ever compete with petroleum hydrocarbons for commercial uses? It's entirely possible, say farsighted students of air-transport logistics.

By extending the range of commercial jet aircraft, some intercontinental flights could be made without costly refueling stops, Olin Mathieson's P. A. Stranges told the New York section of AIChE last month. The polar route from Los Angeles to Copenhagen, for example, now requires a fuel stop at Fairbanks, Alaska. Bypassing this stop would eliminate the need for service facilities and personnel in Alaska.

Whether the savings would offset the high cost of the more potent fuel would depend on just how expensive the fuel is. More-direct processing routes (dotted lines in flowsheet) would go a long way in slashing costs. Stranges hinted that Olin Mathieson is making real progress along these lines.

Stranges also disclosed that OM had added HEF-4 and HEF-5 to its roster of boron hydride fuels. These new products have combinations of properties which OM considers superior to HEF-2, now being made in OM's new Navy plant, and HEF-3, to be made in the big Air Force plant under construction.

Speaking the same day at a meeting in Houston, Gulf Oil's Robert Wells drew attention to the less exotic—and much less publicized—"high-energy" hydrocarbon fuels available from coal tar. These materials—such as decalin, isopropyl bicyclohexyl and perhydrophenanthrene—are more familiar to the dyestuff chemist than to the engineer.

While they show little advantage in Btu./ lb., the coal-tar hydrocarbons have higher specific gravities than petroleum fuels and, therefore, deliver more Btu./gal. They would thus allow aircraft of present designs to fly longer distances without refueling because they would carry more Btu.'s in the same tank volume. Being heavier, however, they would eat significantly into aircraft payload.

Wells thinks that these coal-tar fuels may serve as interim materials to bridge the gap between today's petroleum fuels and the boron fuels of the future.

How to cut waste maintenance time

A virtual "Sears-Roebuck catalog" of maintenance supplies and machine parts has helped chop nonproductive maintenance time by as much as 80% during the past year in Tidewater Oil Co.'s sprawling, 1,600-acre refinery at Avon, Calif.

Catalog is used in conjunction with a materials-delivery system which endeavors to get the right materials to the right job at the right time. Before the huge catalog was prepared, the central storeroom often sent the wrong parts. Many of the refinery's 360 mechanics would have to leave the job to get the needed stores themselves. Some men spent as much as 25% of their time doing this.

Every one of some 12,000 individual items is now specified accurately and quickly by catalog number. Catalog information on IBM cards serves also for automatic reordering of maintenance parts from suppliers.

Lignite to yield uranium, chemicals

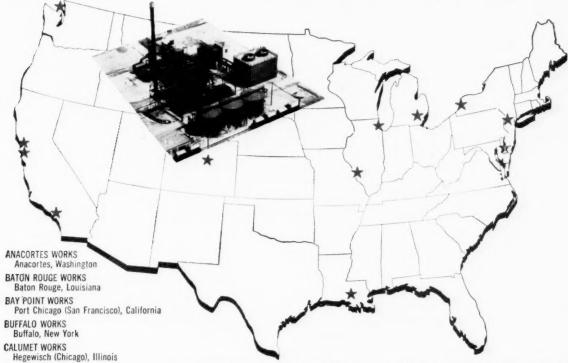
Present plans for winning uranium from Dakota lignite may be only the opening gun of a campaign to tap the values now locked in this vast natural resource.

International Resources Corp., Custer, S. D., has entered final stages of contract negotiations with AEC for a \$6-million mill

(Continued on page 52)

An important message to every sulfuric user interested in spent acid recovery...

2 GENERAL CHEMICAL Plants are equipped to handle spent acid for you



DELAWARE WORKS North Claymont, Delaware

DENVER WORKS Denver, Colorado

DETROIT WORKS River Rouge, Michigan

EAST ST. LOUIS WORKS East St. Louis, Illinois

ELIZABETH WORKS Elizabeth, New Jersey

EL SEGUNDO WORKS El Segundo (Los Angeles), California

RICHMOND WORKS Richmond (San Francisco), California

General Chemical provides industry with sulfuric acid from 18 producing points, located in major centers of commerce from coast to coast. Of these, 12 are equipped to handle spent acid-providing unmatched experience, service and facilities to customers interested in spent acid recovery.

Relatively high strength, impure sulfuric presents many problems of handling and disposal. With General's help you may be able to turn this costly nuisance into an economic asset.

Whether we can help you or not de-

pends on a number of factors: The acid strength . . . The nature and amounts of contaminants . . . The tonnage available . . . The distance of your location from our nearest plant. Generally, spent acids containing 70%-80% sulfuric acid, or higher, can be reclaimed if they do not contain impurities harmful to the equipment.

Our experience in solving spent acid problems of every kind is at your service. For further information, write or call your nearest General Chemical office.



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which would process 600 tons/day (dry basis) of lignite to recover its 0.225% uranium content. Probable location: Bowman, N. D. AEC has already given preliminary approval; contract signing awaits completion by Colorado School of Mines Research Foundation of its evaluation of reserves.

Another prospective uranium-from-lignite producer, Ohio Oil Co., dropped out of the picture last fall because of unfavorable economics. How does IRC expect to make out?

IRC President John McIntyre admits that the uranium mill will do well to break even, especially after U₃O₈ price is frozen at \$8/lb. on April 1, 1962. Possible improvements in process technology might help keep uranium operations slightly in the black.

More important, says McIntyre, are the long-range prospects for recovering power, chemicals and other metals (especially molybdenum), in addition to uranium. Low-temperature carbonization of lignite is a definite possibility for the future.

Process to be used by IRC in its uranium plant has been demonstrated by National Lead at AEC's Grand Junction (Colo.) pilot plant. It consists of fluid-bed roasting of the lignite, followed by quenching, grinding and acid-leaching of the ash. Uranium is recovered from the leach liquor by solvent extraction.

Dust off your conversion factors

English-speaking engineers and industrialists on both sides of the Atlantic are taking steps which may lead to wider use of metric weights and measures.

British Assn. for Advancement of Science has just set up a committee to study the full consequences of changing over to the metric system in the U. K. The group will report on the "practicability, implications, consequences—both international and domestic—and cost of a change-over to the metric system or the decimalization of weights, measures and coinage."

The committee includes scientists, engineers and economists. There are representatives of such industrial concerns as Imperial Chemical Industries and Lever Bros. Study is scheduled for completion by the end of 1950.

Meanwhile, the trend among U. S. pharmaceutical firms to buy, manufacture and sell under the metric system gains momentum. The list includes Eli Lilly, Parke-Davis, Schering, Lederle, Merck and Squibb. Many drugmakers have used metric measures in their own plants for years; others have converted only recently.

Big problem today is to establish metric weights in buying and selling. Merck's chemical division will furnish metric quantities upon request. Yet many suppliers of drugmakers' chemicals stubbornly refuse to ship in metric, or even to stick dual metric-avoirdupois labels on their drums. These include Carbide ("We're not about to change over") and Du Pont ("The answer is no").

Many observers doubt that U. S. chemical producers will ever go metric. Maybe the results of the BAAS study will give U. S. engineers, as well as their British counterparts, a rational basis for evaluating the problem.

Progress in pickle liquor disposal

Blaw-Knox and a consortium of seven steel producers, having reached the \$500,000 plateau on their Ruthner process development program, are now trying to decide if, when and how to meet the pickle liquor challenge.

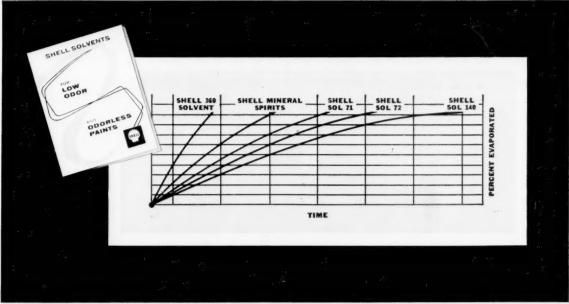
The Ruthner process converts waste pickle liquor into reusable sulfuric acid via formation of a ferrous chloride intermediate which is roasted to produce commercially valuable iron oxide and recycle HCl (see *Chem. Eng.*. Feb. 1956, pp. 132-4).

In a report by the sponsors' committee to American Iron & Steel Institute last month, the 1,440-gal./day pilot plant at Niles, Ohio, was described as a technical success, especially in overcoming some severe corrosion problems. However, comments on the prepared paper brought out strong dissenting opinions, even among the sponsors, as to level of technical accomplishment to date and reliability of cost estimates.

At best, economic picture is cloudy. Despite credits for recovered acid and iron oxide at current prices, operation of a large-scale Ruthner plant would still be a losing proposition. On the other hand, if the pollution problem ever boils down to the question of which disposal process is the least painful, Ruthner enthusiasts claim the process can win out over lime neutralization and other techniques.

Next move by the industry might be erection of a commercial-scale Ruthner plant which would process pickling waste from several nearby steel mills on a custom basis.

For more on DEVELOPMENTS......54



Typical properties of these Shell Solvents are contained in booklet shown. It will be mailed on request.

Where odor is a problem use these

SHELL SOLVENTS

SHELL SOL 71 AND 72

... have no odor, are ideal for interior finishes, polishes and cleaners. Shell Sol 71 offers slightly faster evaporation.

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... much faster evaporation than mineral spirits, low odor, over 100° F. flash point.

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PROCESSES & TECHNOLOGY C. S. CRONAN



INTERLACED belt conveyors transport green and finished coke to and from process kiln.

Carbon Plant Gives Coal Producer Entree

Located in rapidly growing Ohio Valley aluminum complex, new carbon plant can aim at major close-by markets, could kick off integrated coal processing.

Today's traveler wending his way down the curving Ohio River Valley will see an amazing amount of industrial activity as well as the expected natural wonders. One of the latest plants to come on stream in this fast-growing industrial complex is the 165,000-ton/yr. coke-calcining plant of Mountaineer Carbon Co. at Cresap, W. Va., 8 mi. south of Moundsville.

Mountaineer, a joint venture of Standard Oil of Ohio and Consolidation Coal Co. (formerly Pittsburgh Consolidation Coal Co.), turns out a high-purity electrode-grade carbon used by aluminum, electrochemical and

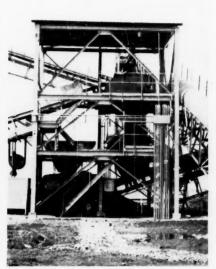
electrometallurgical industries. Mountaineer is the third coke calciner entering the market within the last year, joining Continental Oil Co. and American Gilsonite Co.

Although coke calcining is a long-established operation, Mountaineer's plant shows how careful engineering and close attention to process reactions can improve a "standard" process to increase yield and upgrade product quality.

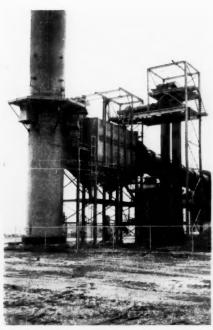
► Enter Green Coke—Right now, plant calcines green petroleum coke from Sohio's refineries, principally coke from Toledo and Lima. Eventually, a sizable portion of plant's capacity may be supplied over the fence from a tar coker associated with a low-temperature coal carbonization unit, provided Consolidation finally acts on now-deferred plans.

Coke from refineries' delayed cokers is "green" because it contains volatile matter. A typical green coke handled by Mountaineer will analyze 5-7% moisture, 9-11% volatile, 0.25% ash and 1.4% sulfur. To render this material suitable for electrode fabrication, the volatile and moisture content must be eliminated. Too, physical properties (as indicated by real density) are altered to improve strength and electrical properties of resulting electrodes.

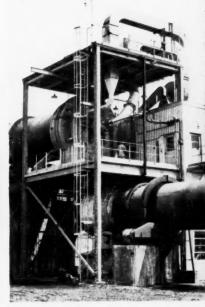
► Exit Calcine—One major outlet for this high-purity calcine is in aluminum reduction—0.5



FEED conveyor delivers coke to crusher for reduction to minus 3 in.



BUCKET elevator charges coke to kiln, drop-out bins recover fines for recycle.



HOT calcined coke drops from kiln into cooler before discharge.

To Integrated Process Complex

lb. of carbon is consumed in making a pound of aluminum. With U.S. aluminum production in the neighborhood of 1.6 million tons/yr., this one market alone accounts for a sizable quantity of electrode carbon.

Mountaineer's new neighbor, Ormet Corp., across the river at Omal, Ohio, is just bringing on stream the first potlines of its new aluminum plant, represents one possible customer for calcine coke. Mountaineer also is located advantageously to sell to other aluminum plants in the Ohio Valley, although company is equipped to serve most of eastern U.S.

Untouched by Human Hands
—One unique aspect of the
Mountaineer plant is the railhead-to-railhead automatic flow
of material.

Green coke arriving by rail

from Ohio is unloaded into hoppers beneath the tracks. Belt conveyors take material from hoppers to a crusher which reduces coke to minus 3 in., then carries it to a pair of 900-ton storage silos. Coke is lifted to feed end of calcining kiln by bucket elevators, and calcined product at other end is automatically weighed and conveyed to three 700-ton storage silos straddling the railroad tracks.

Mountaineer utilizes belt conveyors at all points except kiln feeding because they have proven most economical.

Control Improves Performance—When Ford, Bacon and Davis, Inc., designed Mountaineer's plant, the firm incorporated process features developed by Petrocarb Equipment Co., Inc., working with the Research & Development Div. of

Consolidation. As a result, Mountaineer averages better than 75% yield, several percentage points higher than older installations. And the coke is more uniform in density.

Mountaineer gains these advantages through close control of combustion. A single gas-fed burner in hood at discharge end of kiln generates a temperature of about 2,500 F. Flame configuration, primary and secondary air flows are all controlled carefully; seals cut leakage of unwanted air.

This close control of combustion allows some burning of cracked gases from coke bed. Yet, it prevents unwanted combustion of carbon which reduces yields in most coke calcining. Too, it produces uniform density in finished product, a direct result of uniform temperature.

Kiln is 180 ft. long and 10.5 ft. in dia. Rotating at about 1 rpm., it retains coke approximately 100 min. (Cont'd)

▶ Then Add Water — Hot calcined coke at essentially kiln temperature drops from kiln into a rotating cooler, 8 ft. in dia. and 80 ft. long. Cooling water is injected through sprays into feed end of cooler, overquenching the finer calcine particles but under-cooling the larger pieces.

It's essential that final calcined product be perfectly dry so in remaining length of cooler the larger chunks of calcine contact the over-quenched fines, vaporizing excess water. At discharge end of cooler, dry calcine is dumped at 250 F. onto belt conveyors and carried to storage silos.

Typical product analysis runs 0.2% moisture, 0.25% volatile material, 0.3% ash, 1.4% sulfur, with 2.05 real density.

▶ Fines Are Trapped—Another novel feature of the Mountaineer plant that helps boost total yield figures is the method of dealing with fine calcine that is swept out of kiln in the gas stream.

Before going to the stack, dust-bearing gases pass through a pair of drop-out boxes. Most of the fine calcine is trapped here and returned to the kiln, keeping yields high. Gases from dust boxes, containing appreciable amounts of combustible gases, then flow to combustion zone in stack. Mountaineer doesn't find it economical to recover the heat content of this kiln gas at the present time.

Borane Fuel Process Brought Into Focus

Following formal plant dedication of Olin Mathieson's \$4.5-million boron-based-fuel installation at Model City, N. Y., it's now possible to paint a fairly accurate process description.

Sodium borohydride from Metal Hydride's Danvers, Mass., plant is brought to OM site, loaded into a kettle and slurried with toluene. In a smaller kettle, anhydrous aluminum chloride is slurried with toluene, and both slurries are fed to a reactor where boron trichloride (shipped in via tank car from a nearby Stauffer plant) is reduced to diborane.

Diborane is then pyrolyzed to pentaborane, which in turn undergoes alkylation (believed to be ethylation) to fuel, HEF-2. Alkylation step is reportedly done by reacting pentaborane with a chlorinated hydrocarbon, presumably ethyl chloride, in presence of ferric chloride catalyst.

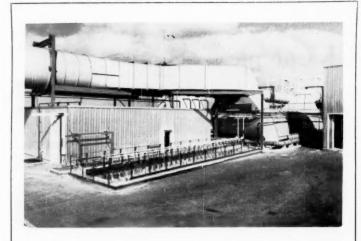
Foamed Aluminum: Looks Like Shiny Sponge Cake

Aluminum foam, developed originally for the Air Force by Bjorksten Research Laboratories, Madison, Wis., is now heading for a place in the commercial spotlight.

Two companies, Foamalum Corp., Peru, Ill., and Dynamic Metals in Houston, Tex., are now commercializing the ultra-light aluminum on license from Bjorksten. Foamalum is currently bringing its facility on stream and is already turning out some sheet and custom-cast foam products. Dynamic Metals plans to erect a \$2-million plant in Houston; it already has a pilot plant capable of producing up to 1 million lb./yr. of foam.

Aluminum foam weighs about 12 lb./cu. ft. compared with 170 lb./cu. ft. for the pure metal. It can be sawed, nailed, cemented, soldered and brazed. Companies are hoping to develop such civilian markets as a fireproof, rotproof substitute for lumber, and use in machined parts and castings. Air Force originally backed development because of potential use in lightweight parts for jet planes.

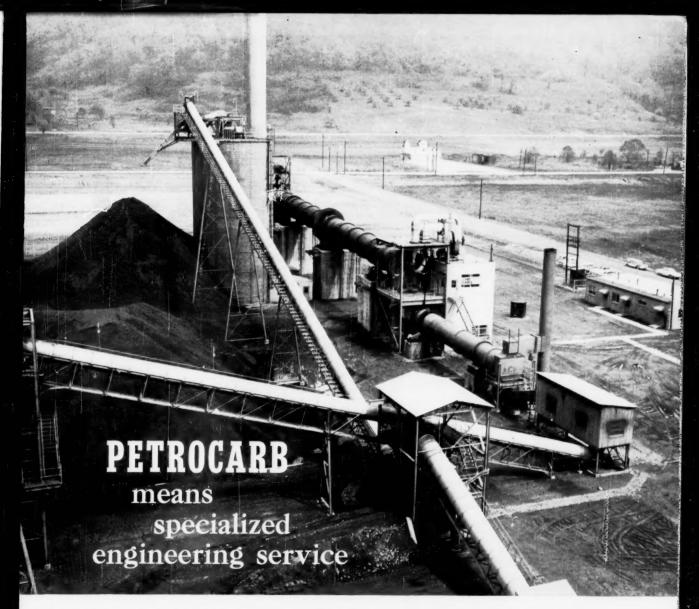
Here's how Foamalum makes aluminum look like shiny sponge cake: Aluminum ingot or scrap is melted and a foaming agent such as titanium, zirconium or magnesium hydride is mixed in. Foaming agent releases hydrogen and the molten aluminum rises like a loaf of bread. Material is quickly poured into molds held at 300 F. below melting point of aluminum for 1 min. while rising is completed.



Lazy Scrubber Knocks Out H2S, Cuts Power Cost

Horizontal scrubber at the Grimsby, Eng., plant of Courtalds, Ltd., eliminates H₂S from plant off-gas while saving on capital investment and yielding a 40% reduction in power costs over conventional vertical scrub-

bers (Chem. Eng., Sept. 1957, p. 139). This is firm's third unit; three more are under construction. Scrubber is the semicircular unit at right; unit in center circulates alkaline scrubbing liquor.



Here's how it helped Mountaineer Carbon solve a problem that may be facing you

Mountaineer Carbon Company is now producing high purity electrode carbon from green petroleum coke in this modern plant at Cresap, W. Va. Credit Petrocarb know-how with a vital assist.

Called in as project consultants, Petrocarb engineers were responsible for process design, equipment engineering, specifications and selection. But the service didn't stop there. Petrocarb assisted in preparing operating directives, helped supervise operator training and actual plant start-up.

Petrocarb offers this kind of specialized, complete, integrated service not only to carbon processors, but to the petroleum, chemical and metallurgical industries and to other engineering and consulting organizations.

HERE'S HOW PETROCARB SERVICE CAN HELP YOU...

Design and erection of: process plants and equipment requiring high temperature operations or refractory constructions ... moving bed reactors ... rotary kiln plants ... metallurgical coke plants ... vertical retorts ... solidsgas contactors ... shaft kilns ... also preliminary reports, feasibility studies, economic evaluations.

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ADDRESS		



CAMERA discloses crystal shortcomings.



GOOD crystals are uniform in size and shape, indicate good graining in batch.



POOR crystals show lack of uniformity which occludes impurities.

Snapshots Guide Growth of Better Crystals

Departing from its accepted role of recording the activities and growth of innumerable American youngsters, Polaroid film now monitors and records how crystals grow. Combining speed and permanence, the film tells quickly when crystallization goes awry. And the developed print is available for comparison with later samples when conditions are improved.

Credit for developing this simple, graphic charting of crystal growth belongs to Senior Technologist George Sloane and Technical Assistant Harry Iwata, Experiment Station, Hawaiian Sugar Planters' Assn. End result of one year's effort, the HSPA grain camera now

helps six different Hawaiian sugar operators keep tabs on sugar crystallization.

Why Take Pictures?—In common with many crystallization processes, production of sugar crystals takes place under constant surveillence. That's because purity of finished crystalline product varies directly with uniformity of crystal size.

Non-uniformity favors formation of aggregates which occlude impurity-laden mother liquor. Not even washing of these crystal aggregates during filtration or centrifuging can remove all the occluded liquor.

That's why sugar operators, and other producers of crystals, try to monitor the operation with speed and accuracy. Then, they are more sure of controlling rate of nucleation and growth to guarantee a uniform crop of crystals.

Sugar people have relied on microscopes to reveal the progress of crystal growth, despite lack of speed and difficulty in comparing successive samples. With the new grain camera, they now record actual crystal size speedily and permanently. The picture is right there for comparison with later ones.

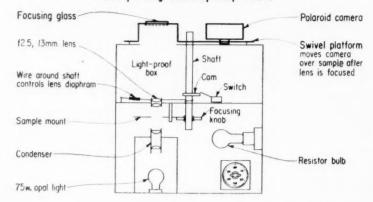
► Camera Becomes Instrument
—HSPA's grain camera, a
standard Polaroid unit with
special 13-mm. focal-length
lens, does the magnifying job
(9 to 10 diameters) once done
by microscope.

Camera is mounted on a rotatable platform atop a lighttight enclosure. Directly across the platform from the camera is a ground glass for focusing prior to taking the picture.

Inside the enclosure, platform holds sample slide during picture taking. A 75-w. G. E. opal light underneath the platform illuminates the crystals on sample slide.

▶ Portrait of Crystal—To photograph a crystal sample, the operator places the slide-mounted sample on the slide platform inside the enclosure. Next, he positions the ground glass over the sample and, with light on, adjusts height of slide platform

Focus, Swing Camera, Snap Photo



WORLD OF EXPERIENCE IN PROCESS PLANTS and 11 udil

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to bring crystals into focus. Then, he spins camera platform to position camera over sample. After taking shot, he waits one minute, then removes print from back of camera.

With a special calibrated glass slide placed over the newly developed print, operator can see at a glance the crystal size. For Hawaiian sugar, 75% of the crystals must be at least 0.6 of a square millimeter to meet the quality control standards.

Refinery Blaze Blamed On Overflowing Dike

Cause of the disastrous fire that raced through Hancock Oil Co.'s Signal Hill, Calif., refinery is being laid to a waterfilled dike encircling a storage tank in a corner of the facility's tank farm.

Apparently oil was being pumped into a storage tank at about 300 F. when the oil began to spill out of the tank. Coming in contact with air at that high temperature, the oil immediately burst into flame. Ordinarily, the dike surrounding the tank would have contained the blazing oil, but the dike was filled with water as an aftermath of recent rains.

Flaming oil surged through the rest of the area, touching off a fire that caused an estimated \$9 million in damage to the \$25-million refinery. About 60% of storage capacity was destroyed along with two-thirds of the rest of the refinery.

Lone consolation in the blaze was the saving of a \$13-million catalytic cracker.



New Ethylene Oxide Unit Uses Oxygen, Not Air

On stream last month, this new ethylene oxide unit at Wyandotte Chemical's Geismar, La., site is the first of three to use Shell Development's process which routes oxygen—instead of air—to oxidize ethylene (Chem. Eng., May 19, 1958, p. 60).

Eliminating nitrogen from the process, Shell explains, reduces fixed investment and operating costs, allows recycle of unreacted ethylene to get optimum economic yield. Above: Reactor section (right), recovery units (left).

Cell Wrings Helium From Natural Gas

In a statement following close on the heels of a recent government plea for greater private investment in helium extraction facilities, Bell Telephone Laboratories has revealed a discovery that will probably make practical the large-scale recovery of helium gas from natural gas.

Our only sources of helium are a few natural gas wells where helium concentration ranges from less than 1% up to 6-7%. Most of this is currently being wasted as natural gas is burned for fuel.

Basis of the Bell discovery is the high permeability of helium through silica or pyrex glass. Under high pressure differential, helium diffuses through glass with only trace amounts of hydrogen (the next most diffusible gas) coming through.

In a small laboratory unit built by Bell, a bundle of glass capillaries (for large surface area) is arranged so that gas mixture flows outside of tubing under high pressure and helium is withdrawn from inside capillaries. Tubing diameter is about 2 mils with a wall thickness of 0.2 mils. Such tubing can withstand over 1,000 atm. at 750 F.

Tests indicate that a cell with two cubic yards of capillary tubing would separate 1,000 cu. ft. of helium per day with a pressure differential of 1,000 atm., assuming a 1% helium concentration in natural gas. Boosting temperature to 750 F. would allow recovery of about 100,000 cu. ft. per day.

Since these cells are essentially permanent, one could be placed directly in a natural gas pipeline for continuous helium production. Studies for commercial applications are now underway.

Centrifugal Extraction Makes Uranium Debut

At its new Mexican Hat, Utah, uranium mill, Texas-Zinc Minerals Corp. is pioneering the application of centrifugal extraction techinques to recovery of yellow cake from ore.



News trom

National Carbon Company

Division of Union Carbide Corporation - 30 East 42nd Street, New York 17, N.Y.

Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. In Canada: Union Carbide Canada Limited, Toronto

HEAT TRANSFER AUTHORITY CONSULTANT TO NATIONAL CARBON COMPANY



DR. DONALD Q. KERN

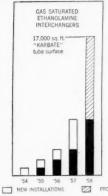
D. Q. Kern and Associates, specialists in thermal design of chemical process units, work with National Carbon Company in developing and applying "Karbate" impervious graphite heat transfer equipment.

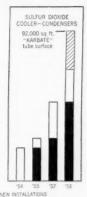
Before establishing his own organization, which serves many U. S. and Canadian companies, Dr. Kern had a distinguished career in industry. Concurrently, from 1943 to 1953, he was professor of chemical engineering, The Graduate School, Polytechnic Institute of Brooklyn. Here he was in charge of advanced instruction in heat transfer and thermodynamics. He is also author of the text, PROCESS HEAT TRANSFER, now in its seventh printing.

"Karbate" Heat Exchangers prove economically superior in corrosive processes

Charts below show expanding use of "Karbate" impervious graphite in three typical corrosive services







"Karbate" impervious graphite resists all concentrations of sulfuric acid up to 60% at temperatures to boiling. This combined with resistance to thermal shock makes "Karbate" heat exchangers logical choices for heating and cooling sulfuric acid.

Long life and moderate costs frequently make "Karbate" heat exchangers the preferred choice over metal units in ethanolamine service. In addition, the improved corrosion resistance permits operation at far higher velocities thus making possible several fold reductions in required heat transfer area.

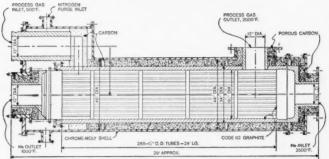
The large surface areas required for cooling — condensing of wet sulphur dioxide containing gases are provided conveniently and economically by "Karbate" shell and tube heat exchangers such as shown below. The corrosive gas is handled on the tube side permitting easy access for cleaning.

"National", "N" and Shield Device,
"Karbate" and "Union Carbide"
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Graphite Heat Interchanger Designed for Use with Nuclear Reactors



This gas phase Interchanger is thermally designed to handle heat generated in a 5 megawatt reactor.

Interest increases in the use of nuclear generated heat for chemical processing applications. In such operations, a gas heat interchanger of the type shown would operate in a loop with the reactor. Hot helium gas from the reactor circulates through the tube side of the exchanger, while process gas to be heated passes through the

Because operating temperatures range from 2000° to 2500° F., "National" Code 82 graphite is well suited for such applications. This low permeability material used for constructing the shell and tube heat exchanger shown provides high heat transfer rates, freedom from corrosion and metallic contamination, and resistance to thermal shock.

Employing moderate instrumentation, mill requires only five operators.

Working on a complex ore, Texas-Zinc grinds to 35 mesh to release CuS mineral which is separated by flotation. Then, sulfuric acid leaches uranium values from the flotation concentrate.

From the leach liquor, Texas-Zinc extracts uranium through contact with tertiary amine solvent in Podbielniak centrifugal extractors. A second bank of machines strips uranium from the solvent with acidified nitrate solution.

Amine in the stripped organic phase is reconstituted with ammonia. Precipitation of yellow cake is controlled with CO₂ produced by neutralization of the raffinate with limestone.

Following satisfactory initial startup, Texas-Zinc has been striving for optimum conditions by seeking greater capacity and improved performance from the amine extractants.



Formaldehyde Route Nets High Yield, High Purity

Now under construction at Castellanza, Italy, near Milan, a 55-million-lb./yr. formaldehyde unit will soon take its place beside two similar ones, pictured above, at the Montecatini Co. site.

Addition of the new unit, which will use Montecatini's patented methanol oxidation process, will hike capacity from

80 million lb./yr. to 135 million

▶ Process Pluses—Key advantages of the process, Montecatini claims, are direct production of high-grade formaldehyde at high yield (90% on a stoichiometric basis), simple design and construction with low installation costs, complete safety of operation and production of a large amount of steam which is used in the process.

Here's how the process works: Methanol is injected into air preheated against gases leaving the converter, then air-methanol mixture enters catalytic converter for reaction. Cooled gases are counter-currently scrubbed with water in a single-stage absorption column. An aqueous solution of formaldehyde (37% by weight) is obtained directly at the bottom of this column.

► Low-Cost Plant — Process, Montecatini explains, trims costs in these ways: There's a low initial cost; price tag, in Italy, for the 55-million-lb./yr. plant is about \$300,000. Too, product purity (less than 1% by weight of methanol, less than .008% by weight of formic acid) is such that methanol distillation equipment and ion exchange to remove formic acid are not necessary.

Catalyst for the process Montecatini describes only as "a special catalyst consisting of metallic oxides." Process requires 0.4 cu. ft of water and 0.03 kwh. of energy per lb. of formaldehyde product. Process recoups steam at 280 psig. at a rate of 0.35 lb. per lb. of product.

News Briefs

Synthetic rubber: Nazionale Idrocarburi's president Enrico Mattei has announced that Europreme rubber produced at ANIC's Ravenna, Italy, rubber-from-methane plant would seek U.S. markets. Price, depending on quantity, will be 25-28¢/lb., f.o.b. Ravenna.

Molybdenum: Climax Molybdenum Co. will build a \$1-million plant at Coldwater, Mich., to produce molybdenum and alloys based on molybdenum.

With capacity to produce 800,000 lb./yr., plant will include two vacuum-arc, consumable-electrode melting furnaces, especially developed for molybdenum production.

Refinery: Socony Mobil Oil Co. de Venezuela has awarded a contract to M. W. Kellogg and its subsidiary, M. W. Kellogg de Venezuela for design and construction of a new refinery at El Palito, Venezuela. Facilities will include 40,000-bbl./day single-stage atmospheric distillation unit, 6,000-bbl./day catalytic reforming unit and a caustic treating unit; refinery will come on stream in late 1959.

Grate-kiln system: Allis-Chalmers Mfg. Co. will construct a new, \$250,000 prototype model of its grate-kiln system at Carrollville, about 15 mi. south of Milwaukee, Wis. Scheduled for operation this fall, system will have better feeding and pelletizing facilities, a larger traveling-grate section (13 ft. long by 22 in. wide), a larger-capacity 42 .in.-dia. rotary kiln about 18 ft. long and newly designed circular cooler with increased flexibility.

Nitrous oxide: U. S. Army Corps' Engineering Research and Development Laboratories has awarded a contract to Lummus Co. Engineering Development Center for design, construction and testing of a skid mounted nitrous oxide generator. Unit, to be operated at Lummus development center at Newark, N. J., will turn out 40 lb./hr. of liquid nitrous oxide from an ammonium nitrate feed material.

Aluminum: France is mapping plans to boost aluminum production by 70% within the next two years to meet rapid rise expected in French consumption. Output of the two French producers, Pechiney and Ugine, will rise from last year's 175,000-ton/yr. mark to a total of 302,000 tons/yr. in 1960.



CHEMICAL PRODUCTS EDITED BY FRANCES ARNE



Polystyrene Film

Sells for less than most transparent films; equal or better quality.

A new packaging film selling for less than most competitive transparent films has been made possible by the development of an economical film forming process for inexpensive polystyrene.

Trademarked Trycite, the film will be produced by Dow in Cleveland. Plant will go on stream in January 1959. Market potential is believed to be so large that studies to further expand production have already been started.

Initial markets for the film will be those held by the cellulosics, cellulose acetate and cellophane. The new film is said to equal or better these competitors in terms of appearance, printability, ability to be handled on conventional packaging machinery. Distinguishing strong points, however, are Trycite's low cost and resistance to ageing.

Some idea of Trycite's price advantage can be gained from the fact that 1 lb. of it will make a 25,000-sq. in. film, 1 mil thick. This compares to only about 18,000 sq. in. of cellulosic film.

Trycite ages well because, unlike competitors, it is not dependent on either moisture content or a plasticizer for flexibility. It contains no plasticizer and absorbs virtually no water. There is nothing to bleed out or to exude from the film to cause release of the printing or to cause the film to become sticky or forgy.

Fields where the value of these properties is immediately apparent include packaging of soft goods such as handkerchiefs and hosiery, wearing apparel and textiles, dairy, drugs and groceries. The nature of many of these products accommodates long shelf life and long distribution channels. It has not always been possible to find packaging materials which stand up as well as the products themselves.

Polystyrene produces a breathing film which transmits moisture vapor or gases. And it is not heat sealable. These are among the reasons why it is not expected to compete, in the immediate future, with polyethylene or saran which are classed as barrier films.

However, work is now being done on the development of coatings which would allow custom tailoring of polystyrene film to more applications, e.g., those which require a barrier film.

To make polystyrene film commercial, Dow had to develop a method for economically orienting the film, a mechanical stretching of the plastic in two directions which realigns the molecules into an orderly arrangement. It is this orderly arrangement which gives the film outstanding mechanical properties. The film's high gloss, clarity and chemical resistance are inherited characteristics of the base polymer.

There is one other domestic producer of oriented polystyrene film: Plax Corp. However most of its emphasis has been on sheeting which may be defined as films over 3 mils in thickness. Packaging materials are usually 2 mils or less in thickness.—

Dow Chemical Co., Midland, Mich. 64A

Silicone Rubber

Extremely hard, general purpose compound.

Designated Union Carbide XK-1039 silicone rubber compound, a new 85±5 Durometer hardness material has low compression set, low moisture absorption, high temperature stability, good release properties, and does not require the use of toxic additives.

It can be easily molded, calendered, or extruded. It is particularly suited for fabrication of rubber rolls which are used in the textile, plastics, paper and printing industries.—Silicones Div., Union Carbide Corp., New York, N. Y. 64B

Rubbers

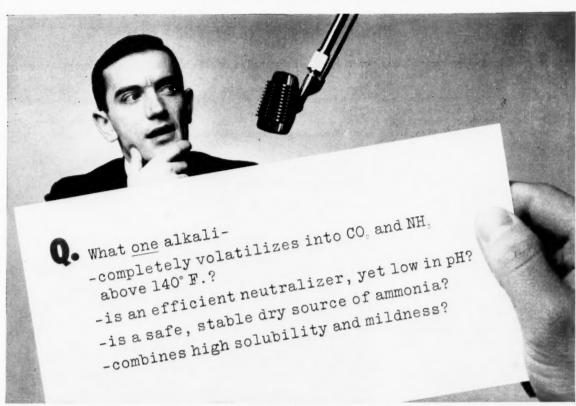
A more rubbery rubber and a liquid rubber.

Two new forms of rubber have been synthesized recently. One, called deuterio rubber, is described as more rubbery than the natural product; the other is a liquid rubber.

In deuterio rubber heavy hydrogen (deuterium atoms) obtained from heavy water, replace the conventional hydrogen atoms attached to the carbon chains in the molecules of ordinary rubbers. Because molecules containing deuterium atoms attract each other less strongly than do those containing hydrogen atoms, this exchange results in a more fluid, elastic rubber.

High cost restricts its use to that of a research tool. Eventually, a rubber of this type might be made and used for some very special purposes. At present, its great value will be in helping scientists to learn more about the properties of conventional rubbers.—Goodrich-Gulf Chemicals, Inc., Cleveland, Ohio. 64C

The preparation of liquid rubber has been reported. Known as Adiprene L, the liquid form of the material can



A. SOLVAY AMMONIUM BICARBONATE

The distinct and unusual combination of properties of SOLVAY Ammonium Bicarbonate make it a valuable material in many processes. These properties include: the ability to completely volatilize at temperatures above 140°F., leaving no residue; to neutralize fairly strong acids (although its pH is only slightly above neutral); and to provide a safe, effective source of ammonia for dry compounds.

SOLVAY Ammonium Bicarbon-

ate's properties have been used in such widely diverse applications as: biscuit and cracker baking, where it is used as a leavening agent; leather manufacture, where it is used to neutralize acid; and in the chemical industry, as a dry source of ammonia.

These uses and properties of Solvay Ammonium Bicarbonate may suggest a worthwhile application to you. Mail the coupon for a test sample and specific facts.

Physical and Chemical Properties

Negative heat of solution. Stability: Relatively stable at room temperatures

Volatility increases sharply above 140°F.

Decomposition product ratios are as follows:

Ammonia gas (NH1) ... 21.5%
Carbon dioxide gas (CO2) ... 55.7%
Water vapor (H2O) ... 22.8%
pH of 1/10 N solution at 25°C.: 7.8%
Appearance: White crystals.
Quality: Exceptionally pure. Food grade.

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Very low metal content.

be cast in molds, sprayed or applied by dipping to produce a wide variety of mechanical goods and protective coatings. The liquid is then transformed into a solid elastic rubber by a curing process which takes five minutes to 24 hrs.

After curing, Adiprene L products are said to exhibit high tensile strength and resilience combined with excellent resistance to abrasion, compression set, oils, oxidation and ozone. In addition, this material was reported to have excellent properties at low temperatures.—Du Pont Co., Wilmington, Del. 64D

Plasticizer

Fast-fusing primary plasticizer for PVC tile, film.

A new, fast-fusing primary plasticizer for polyvinyl chloride is said to impart good general purpose properties to floor tile, plastisols, film and sheeting, extrusions and other formulations at low cost.

Trademarked Santicizer 165, it is a chemically blended mixed alcohol phthalate offering good heat and light stability and a low temperature flexibility equal to that of dioctyl phthalate. Its volatility, while slightly higher than that of DOP, is far lower than butyl octyl phthalate.—

Monsanto Chemical Co., St. Louis, Mo. 66A

N-Butylene Isomers

Pure, unmixed isomers.

Until now, butylenes have beeen commercially available only as mixed isomers, mainly from refinery catalytic cracking operations. Commercial quantities of high purity butene-2 and butene-1 concentrate are now available.

For existing uses of the mixed isomers, the high purity butene-2 stream will aid the processor by virtually eliminating the large amount of nonreactive butanes which his equipment has been required to handle.

The separated n-butylene isomers will be of interest where

each gives a different product. In such cases, mixed butylene feedstocks would yield a mixture of products that might be difficult to separate or, if separated, one might have no market—Texas Butadiene & Chemical Corp., Houston, Tex. 66B

Phthaloyl Chlorides

Raw materials for synthetic fibers, films, coatings.

High purity isophthaloyl chloride and terephthaloyl chloride are now available in pilot plant quantities.

In view of projected commercial-scale prices, they are expected to be important raw materials for synthetic fibers, films and protective coatings. They should also prove useful in the chemical, pharmaceutical, plastics and dyestuffs fields.

These new difunctional compounds, supplied as white solids, exhibit greater reactivity as well as greater solubility in many organic solvents as compared with the corresponding acids.—Hooker Electrochemical Co., Niagara Falls, N. Y. 66C

Aluminum Paint

Said to have greater adhesion, increased brightness.

Recent improvements in the formulation of aluminum paint Heat-Rem H-170 are said to make possible the effective painting of many types of equipment formerly regarded as unpaintable due to temperature limitations.

Improved properties are attributed to a new suspended combination of non-leafing and leafing aluminum in the paint compound. Unlike ordinary aluminum, non-leafing particles are said to remain equally distributed throughout the H-170 vehicle and to provide uniform coverage of aluminum in the applied paint coat. Fusion of the paint with hot metal surfaces is thought to form a protective coating withstanding temperatures up to 1,700 F.

It is recommended for use on heat transmission lines, traps, stacks, vents, condensors, compressors, ovens, engine heads, mufflers, radiators, jet missile tubes.—Speco, Inc., Cleveland, Ohio. 66D

BRIEFS

Red dyes, the first to possess the properties of the phthalocynine pigments have been developed. Called Monastral Reds, they are said to excel in brightness and intensity, lightfastness, heat, chemical and bleed resistance. Applications are expected in automotive and industrial finishes, house paints, printing inks, textile fibers, plastic products.—Du Pont Co., Wilmington, Del. 66E

Phenol-formaldehyde resin is used instead of sulfur in a new vulcanizing system which increases the upper temperature limit of serviceability of butyl rubber by 100 F. (Chem. Eng., Dec. 1957, p. 180).—
U.S. Rubber Co., New York, N. Y. 66F

Appetite supressant, 1-phenyl-2-aminopropane alginate, does not cause insomnia as do the amphetamine compounds, widely used for weight reducing. This was the finding of a recent series of clinical tests on the product, called Levonor. — Nordmark Pharmaceutical Laboratories, Irvington, N. J. 66G

Colored tire treads, made possible through the use of white hydrated silica reinforcing pigment Hi-Sil 233, are said to exhibit tread life in road tests approximating 85% of that of conventional first line black tread tires.—Columbia-Southern Chemical Corp., Pittsburgh, Pa. 66H

For More Information . . .

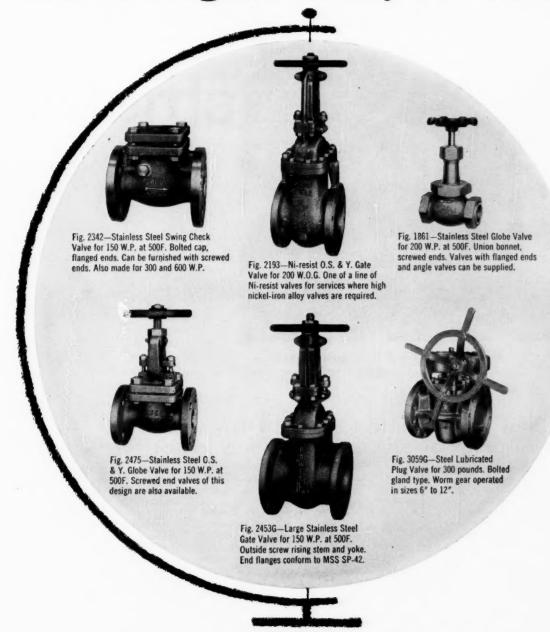
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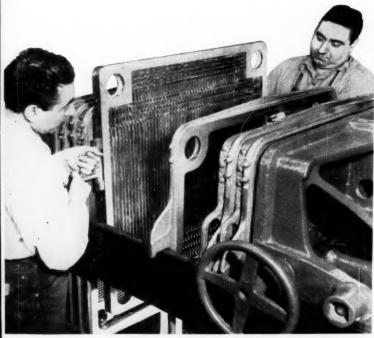


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DEVELOPMENTS ...

PROCESS EQUIPMENT EDITED BY C. C. VAN SOYE



Molded polyester filter plates offer improved chemical resistance, lower cost and decreased weight.

New Filter Plates: Plastic Displaces Metal

M older polyester looks like an answer to the long-standing need for a filter plate with a unique combination of allaround properties — versatile chemical resistance, good mechanical characteristics, reduced weight and low cost.

Introduced only about six months ago, several hundred 36-in. plastic plates are already in use for production operations at the plants of several major chemical producers.

▶ Resists Attack, Smooth—The new plates, developed by the T. Shriver & Co., Inc., show a wide range of corrosion resistance. Molded from Thermaflow 100, a reinforced polyester molding compound manufactured by Atlas Powder Co., the plates have good-to-excellent

resistance to hot mineral acids and alkalis, hypochlorites, peroxides, chlorides and organic solvents.

Being compression molded, the surface of the polyester plates is smooth and free of pores and pits that might trap sediment. Also, the smooth surface permits more thorough cleaning to reduce the possibility of product contamination between different batches.

Furthermore, being a homogeneous material throughout, the plates are not subject to the corrosion or deterioration problems common to coated plates when protective coating chips or abrades in service. The polyester machines easily—ground joint surfaces therefore boast a perfect parallelism that pro-

vides leak-tight seals between plates and frames.

Lower Weight, Cost — Polyester plates weigh only about as much as plates of the same size made from standard corrosion-service materials such as coated cast iron, nickel-iron, bronze and stainless steel. Thus, a 36-in. polyester plate weighs about 80 lb., whereas the same plate in cast iron or bronze weighs 265 lb., and in stainless steel, 200 lb.

Translated into shipping considerations, this weight reduction means an aggregate saving of 2-3 tons for an average 30-plate, 36-in. press. And, the lower weight of individual plates makes them much easier to handle and separate when

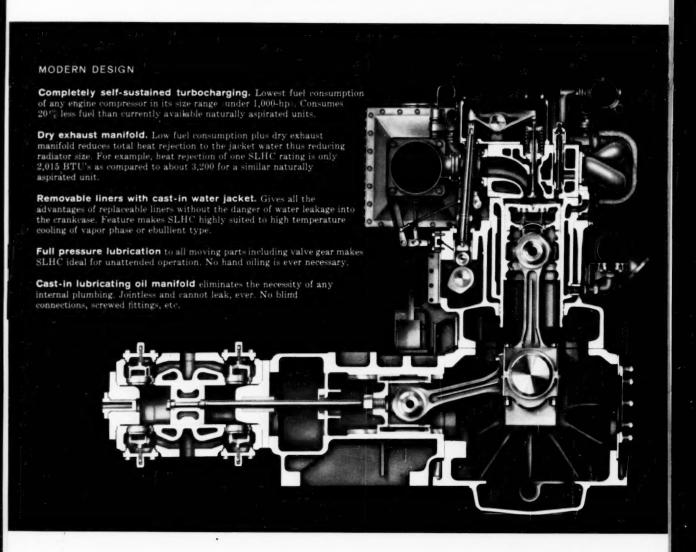
(Continued on p. 74)

Don't pay today's prices for yesterday's engines!

Read on following pages how the new Worthington SLHC engine compressor can substantially reduce your gas handling costs



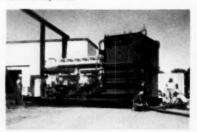
Only SLHC Turbocharged Gas-Worthington offers all these



Six-cylinder SLHC unit installed by Northern Natural Gas Co. in the Oklahoma Panhandle.



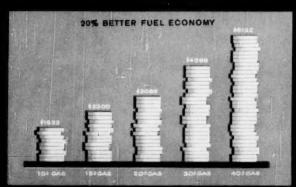
One of three 6-cylinder skid-packaged SLHC units being prepared for shipment to Bolivia, S. A.



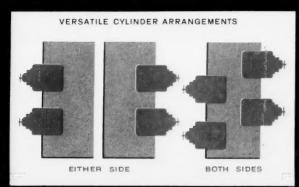
Six-cylinder skid-packaged SLHC unit for service in a Louisiana gas field.



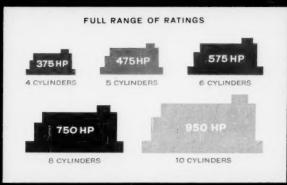
Engine Compressor by modern, dollar-saving features



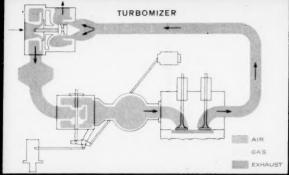
The SLHC will give you about 20% better fuel economy than currently available naturally aspirated units. This chart shows the savings per year for each 1000 hp of continuous operation on natural gas.



Piping and construction problems can be greatly simplified thanks to versatility of cylinder arrangements on SLHC. Cylinders can be mounted on either or both sides. If mounted on both sides, SLHC permits twice as many cylinders as most engine compressors in its size range.



These are the range of ratings offered in the SLHC. Note that all units operate at the conservative speed of 450 rpm with a conservative bmep of under 135 psi. All units may be skid "packaged" — including the 950 hp rating, the largest available for this type service.



Worthington's Turbomizer is the simplest fuel control system on the market. It offers remarkably favorable fuel consumption and stable operation over the complete load and speed range. Allows operator to compensate for different fuels and heating values in one adjustment.

One of two 4-cylinder SLHC engine compressors to be installed by Permian Basin Pipeline Co. in Lea County, N. M.



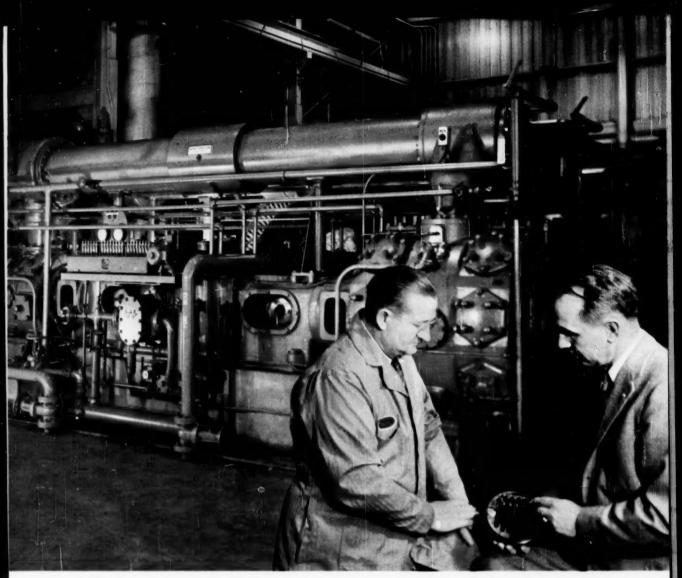
Six-cylinder skid-packaged SLHC gasengine compressor for a Texas natural gasoline pant.



For complete details, get in touch with your nearest Worthington district office. Or write to Worthington Corporation, Section 43-1, Harrison, N. J. In Canada: Worthington Canada Ltd., Brant ford, Ont.

WORTHINGTON





User-survey shows - in all operating categories

FEATHER VALVE VOTED BEST

Simplest Construction:

FEATHER VALVE

VALVE B

Lowest Maintenance:

FEATHER VALVE

A recent survey among compressor users showed this marked preference in all four operating categories for the amazing Feather * Valve. The Worthington Feather Valve is the lightest, fastest-acting compressor valve available. Because of its lightness and flexibility it provides very sharp action with virtually no slip or back-flow. And because it works with no impact . . . has no buffer plates or cushioning

Most Efficient:

FEATHER VALVE

Ouietest:

VALVE B

devices . . . it is all but indestructible, assures long-life with negligible maintenance costs.

To get the most in performance when you buy your next compressor, specify Worthington with the rugged Feather Valve feature. Worthington Corporation, Harrison, N. J.

WORTHINGTON

New Invention Cuts Waste Disposal Costs By Two-Thirds in Chemical Processing Plants

Industry Cost Averages May Be Lowered Soon

If your plant is average, you're probably spending between .55 and .85 cents for every cubic yard of waste or trash moved to the disposal area . . . not including truck operation costs.

A recent development, the DEMPSTER-DUMPMASTER self-loading packer, promises to cut direct disposal costs to a new industry low of .07 to .16 cents per cubic yard for volume producers.

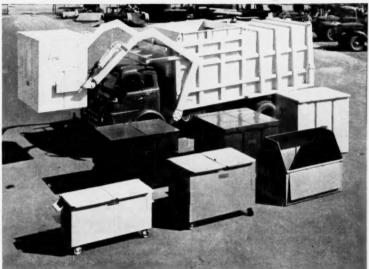
This new approach is an extension of the widely-established DEMPSTER-DUMPSTER System, in that it employs detachable waste storage containers. However, instead of carrying each container to the disposal area for dumping, the new machine empties many containers into its body, where the material is compacted to a fraction of its former volume. This permits pertrip payloads of 50 to 100 cubic yards of loose material, depending on its characteristics.



Multiple exposure photo shows dumping of 6 cu. yd. container.

How it Operates

The one-man Dumpmaster makes its rounds from container to container. Approaching, the driver engages lifting channels on the container's sides with the clearance arms. From controls in the cab, or remote controls at the front bumper, the container is lifted and rotated, discharging waste into the packer body. The material is hydraulically compacted while enroute to the next location. Containers may also be handled from docks or below grade. The safety clearance arms



The newly developed DEMPSTER-DUMPMASTER is shown with the seven basic containers it serves. Being hoisted is a 6 cu. yd. model. On ground are 1, 2, 3, 4 and 5 cu. yd. designs. Open container is used for hand-loading service.

New "Tracking" Caster Developments Make Plant "Container Trains" Practical

To whip the high cost of moving refuse outside, many plants are going to "container trains." Using special casters and couplers, eight to ten containers are towed by "plant mules" to inside generation points where an empty is dropped off and the full one is coupled on. Outside, the containers are uncoupled and automatically emptied by the waiting DUMPMASTER.

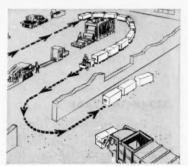


Diagram shows containers, in train, being hauled outside for emptying.

never pass the cab windows, eliminating possibility of driver injury.



Many Designs Available

Standard and special-purpose containers, ranging from one through six cubic yard capacity, with or without casters, are available. The two cubic yard container above holds the equivalent of over 12 30-gallon trash cans.

Cost-Finding Book Offered

Write for the free 40-page book, "How to Cut Waste Disposal Costs," offered by the manufacturer. It contains cost-finding formulas, solutions to problems, case histories, industry average costs, etc. Equipment demonstrations arranged on request.

DEMPSTER BROTHERS

KNOXVILLE, TENN., DEPT. CE-6

the press is opened to remove filter cake.

In addition to these advantages, polyester plates offer substantial economy over other chemically-resistant materials. For example, a 36-in. plate costs about 10% less than a good-quality, rubber-coated cast iron plate; selling price is about \(\frac{1}{2} \) as much as an 18-8 stainless steel plate.

► Availability — Although currently available in only a 36-in. size or smaller, larger plates are entirely practical, and can be produced on request. Shriver's plates interchange with other plates used in presses of the same type.—T. Shriver & Co., Inc., 876 Hamilton St., Harrison, N. J.

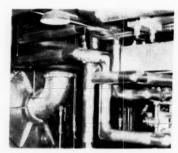


Filter Media Support

Honeycomb structure permits unobstructed flow.

The new Trilock filter media support, woven from Saran and polyethylene fiber, is claimed to increase filter media life and eliminate the need for undercovers. This ability is attributed to its smooth surface, as compared to conventional coarse woven wire or perforated plate.

Although Trilock fabrics are primarily intended as media supports and drainage members for wet process filters, other natural fields of application open with general acceptance. For instance, with envelopetype dust collectors, they support the collector bags. Also, several layers of Trilock can act as a mist eliminator within towers and similar equipment.-National Filter Media Corp., 1717 Dixwell Ave., New Haven, Conn. 74A



Insulation Jackets

On the average, installation takes only 9 min.

A new aluminum jacketing product quickly encloses right-angle turns of insulated pipelines, long a jacketing trouble spot. The almost squared-off elbow cover abandons form-fitting customs usually followed in applying jacketing materials, thus greatly simplifying installation. Jackets fit both sharp and gently curving turns—insulation need not be cut away.

Installation involves placing of the deep-drawn halves around insulated turns, then joining them with aluminum screws. Twelve sizes fit 107 combinations of pipe diameter and insulation thickness, up to an overall O.D. of 12.8 in.—General Aluminum Supply Co., Kansas City, Mo. 74B



Magnetic Trap

Permanent magnet removes tramp iron from liquids.

A new series of stainless steel, full-flow magnetic traps combines positive protection against tramp metal in liquid lines with easy, instant cleaning—without removal of traps from the line.

Liquid flows in a wide stream

over the intensive magnetic field with minimum agitation and friction. A simple ring clamp, when unfastened, releases the various assembled parts for cleaning. Comes in 2-, 3- and 4-in. sizes. — Ladish Co., Tri-Clover Div., Kenosha, Wis. 74C

Hot Pump

For pumping liquids that set up on cooling.

A new line of standard centrifugal pumps transfers heat to liquids being pumped. Designed especially for liquids which congeal, solidify or crystallize with loss of heat, the pumps incorporate tracings and jacketings for the casing, stuffing box and suction nozzle.

Available in either iron-fitted steel or stainless, the pumps have working pressures to 400 psi. — Dean Brothers Pumps, Inc., 323 West 10th St., Indianapolis, Ind. 74D

Slide Gate

Eliminates close-tolerance sliding surfaces.

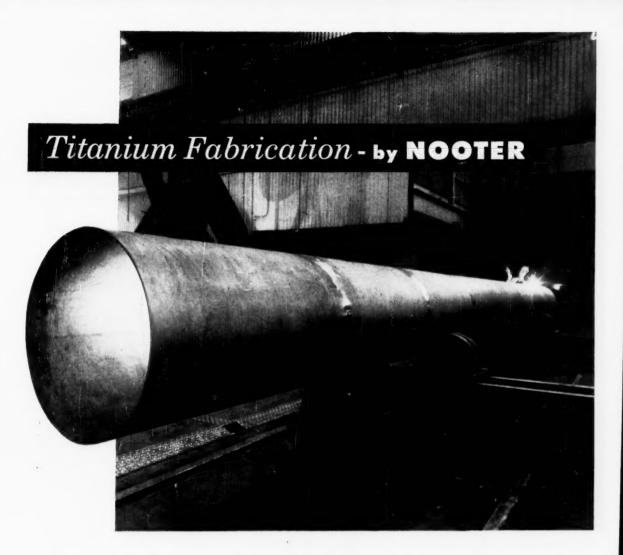
Type SL slide gate, a newly designed hopper shut-off valve, assures dust-tight bin closures without sticking.

In operation, movement of the shaft handle inward to the stop position centers the circular gate beneath the inlet. Clockwise rotation of the handle then cams the gate upward to lock it firmly against the sealing surfaces of the opening. Reverse procedure breaks the seal and moves the gate out of the path of discharging material.—The Ducon Co., Inc., 147 East 2nd St., Mineola, N. Y. 74E

Slide Rule

New engineering tool solves problems faster.

According to the manufacturer, just one quick setting of the new Chem-Rule will frequently give answers normally requiring time-consuming reference to tables and atomic charts.



And the RARER METALS ...can be put effectively and precisely to work for you by Nooter.

Such metals as . . . zirconium, tantalum, titanium. Metals with the capacity to withstand high temperatures and to resist corrosion. Metals with these and other special capabilities to meet the ever-increasing special demands of our very special age. And now at your disposal . . .

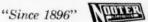
Nooter can and is now welding any type of zirconium, tantalum, or titanium plate fabrication . . . with single or multiple pass welding, fully X-rayed. In titanium work, the metal can be either commercially pure, or in some alloyed forms.

The welding and fabrication of these new metals is a pioneering task, exacting the highest skill and ingenuity from those who would

unlock and put to use their special capabilities. It is not a new role for Nooter, with more than a half-century of experience as a custom fabricator. Through continuous, painstaking and imaginative metallurgical, fabricating, and welding research, Nooter over the years has led the way in developing techniques for working and welding many new metals and alloys.

And now...the RARER METALS! When they fit your needs, let Nooter put them to work for you.

NOOTER CORPORATION

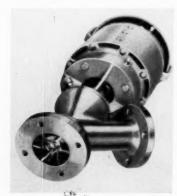


Steel and Alloy Plate Fabricators and Erectors . . "Boilermakers"

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One side of the rule contains special scales for solving temperature, pressure and solution concentration problems quickly and accurately—with just one setting.

Other scales on the special side aid work in liquid-vapor equilibrium relationships, P-T relationships for saturated steam, pertinent data for adiabatic expansion and compression, etc. The reverse side of the rule contains the standard scales—C, D, A, LL3, etc. Laminated bamboo construction.—Frederick Post Co., Box 803, Chicago 90, Ill. 74F



Pipeline Mixer

Combines mixing and highshear homogenizing.

Claimed by the manufacturer to be the only mixer of its kind to join continuous-flow mixing with high-speed, high-shear homogenizing, the "Pipe-Line" homo-mixer combines any liquids, gases or solids that can flow through piping. Immersible parts on standard models are stainless steel.

A motor-driven turbine draws unmixed materials into a homogenizing zone and forces them through the restricted openings of a mixing head, where they are subject to intense shear and impact forces. Agglomerates break down and mix thoroughly.

"Pipe-Line" comes in six power-input sizes—½ to 25 hp.; nominal outlet-line diameter for this span varies from 2-8 in.—Gifford-Wood Co., Hudson, N. Y. 76A



Filtering Centrifugal

Separates and washes filterable slurries.

An automatic, horizontalshaft, continuous filtering centrifugal, referred to as the Model HS-66, features rubber linings on all internal parts contacting filtration liquids. Powered by a 125-hp. motor, the electrically timed machine is capable of handling loads up to 20.5 cu. ft. of material per batch.

The variable-speed drive, which is water-cooled, spins the 66-in.-dia. drum up to speeds of 125-640 rpm. in just 40 sec. Quick fingertip control of the steel door provides easy access for inspection and media change.—Baker Perkins, Inc., 1000 Hess, Saginaw, Mich. 76B

BRIEFS

Air-line device, the Lub-Air-Ator, improves the efficiency of air lines serving controls and instrumentation. It filters air, regulates pressure and lubricates lines.—A. Schrader's Son, 470 Vanderbilt Ave., Brooklyn, N. Y. 76C

Regenerative heater line, which takes waste gases at temperatures to 1,000 F., can handle flows to 250 cfm. The small rotary air-to-air exchangers have a diameter of about 20 in., depth of 11 in.—The Air Preheater Corp., 60 East 42nd St., New York, N. Y. 76D

Radiation pyrometer, the Shawmeter, measures solid, liquid and flame temperatures in the 1,500-4,000 F. range. The instrument, accurate to 20 deg., does not require emissivity corrections.—Shaw Instrument Corp., 49 Verona Rd., Pittsburgh 21, Pa. 76E

Vibrating screen, the new heavy-duty Straightline CL-

Model 58, exhibits a vibrator gear mounting designed for easy maintenance. Screen can be either cable suspended or floor mounted. — Link - Belt Co., Prudential Plaza, Chicago 1, Ill. 76F

New motor design, called F/A (fully accessible), permits a.c. motor enclosures to be manufactured separately from the wound stator. Makes stator accessible for thorough inspection. — Westinghouse Electric Corp., Box 2278, Pittsburgh, Pa. 76G

Level indicator contains no moving parts or relays, and delivers up to 10 a. to indicate or control liquid level. The optical instrument uses a photoelectric sensing probe.—Revere Corp. of America, Wallingford, Conn.

Equipment Cost Indexes

	Dec.	March
	1957	1958
Industry		
Avg. of all	229.2	231.2
Process Industries		
Cement mfg	220.7	222.9
Chemical	230.4	232.4
Clay products	214.4	216.6
Glass mfg	217.6	219.4
Paint mfg	221.6	223.8
Paper mfg	222.0	223.9
Petroleum ind	226.3	228.6
Rubber ind	229.1	231.4
Process ind. avg	227.0	228.8
Related industries		
Elec. power equip	232.9	234.2
Mining, milling	231.8	233.8
Refrigerating	258.9	261.5

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124-6 for method of obtaining index numbers; Feb. 24, 1958, pp. 143-4 for annual averages since 1913.

Steam power..... 216.9 219.5

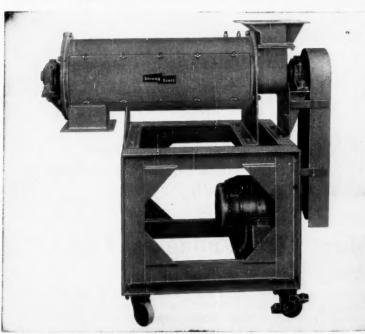
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postcard (p. 151)

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ON MIXER
TWIN ROTOR MIXERS are designed primarily for high percentages of liquid application to light weight ingredients, where product identity is to be mainproduct to tained. A double shaft assembly with overlapping, adjustable paddles gently combine the liquids with the dry mix.

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It is also highly applicable where a fluffing action is desired on powdered material. Minor percentages of liquid may easily be added to dry mix with high efficiency and dispersion results.

The TURBULIZER is self cleaning and is built with sanitary seals at each end of the shaft. The interior is precision machined. Overlapping, adjustable paddles turn within a close tolerance to the chamber wall, providing a selective rate of material flow.

The TURBULIZER may be furnished in carbon or stainless steel and may be jacketed for hot water, steam or a refrigerant. Capacities will vary depending on the bulk density of the material and the degree of agglomerates encountered. Consult Strong-Scott for full details.



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better technology will spark new peacetime markets

Metal Supplies: More Than Enough at Last

Cecil H. Chilton, Senior Associate Editor

As far as producers and consumers of metals are concerned, the war is finally over.

Today's supply-demand picture for metals is unique in the industrial experience of many latterday chemical engineers. For the first time since the beginning of the defense buildup prior to World War II-a period of nearly 20 years-all major metals are in adequate supply.

They are, in fact, in excess supply, as overexpansion of production capacity has been complicated by recession-softened markets. Even nickel, often considered the most critical of defense materials, is now seeking customers. And the only "wonder" left in the wonder metal, titanium, is the producers' lament, "We wonder where the markets went."

With some metals, such as nickel and uranium (Chem. Eng., June 2, 1958, pp. 72-74), the market picture is still quite healthy—capacity has simply overtaken demand. Other metals, (e.g. steel, copper and aluminum) are suffering primarily from the general downturn in the economy.

Some of the effects of this situation are fairly obvious: lower prices, reduced earnings, idle plants, cancelled or stretched-out construction problems.

► Counterpunch—Not so obvious, but more important to chemical engineers, are the challenges this situation presents to metal technology and market development. For in these areas lie the best hopes for a resurgent growth in peace-

Economic pressures call forth efforts to develop cheaper processes. If titanium. for example, ever becomes a major commercial metal, it will be through improved technology permitting lower prices.

Another significant byproduct of abundant metal supply is stepped-up research activity to find new markets. The copper and lead industries have recently announced associationsponsored market development programs. International Nickel looks upon today's situation as a challenge to pump new life into markets which atrophied during the long years of nickel

▶ Plenty of Life Ahead—So despite the cloudy short-term outlook, most metal producers are optimistic about the long-range picture. Stepped-up defense spending, dwindling inventories, rising population and living standards, research-all portend a bright future.

Many companies are proceeding with expansion and modernization projects so they will be prepared to take full advantage of the upswing when it comes. ► Steel Shows the Way—This is especially true of the steel industry, which expects to add 30-40 million tons of capacity in the next 10-12 years. This year's outlay for new equipment and construction will be \$1 billion. While this is down appreciably from last year's \$1.75 billion (highest year on record), it's still a sizeable sum.

Steel producers are painfully aware of the high cost of new capacity today, especially when they compare it with woefully inadequate depreciation reserves based on original cost of capacity installed some 20-30 years ago. They are therefore giving top priority to developwhat

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With... beta PROPIOLACTONE

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now available in commercial quantities

Latest news in intermediates is beta-Propiolactone (BPL), a starting material with remarkable versatility—difunctionality—that immediately suggests the synthesis of important new products. How can you use BPL—or its derivatives? In starch emulsions? In adhesives? In textile fibers? Why not find out immediately?

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TYPICAL PROPERTIES OF CELANESE BPL

beta-Propiolactone, wt., % min.

%min. 97
Physical state Liquid
Color Colorless
Odor Pungent.

Odor Pungent, acrylic
Boiling Point, deg. C. 162

 Refractive index @ 20°C
 1.4131

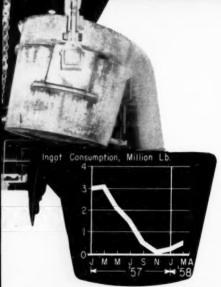
 Specific gravity @ 20/20°C
 1.1490

 Pounds per gallon @ 20°C
 9.56

 Flash point, Tag open cup, deg. F.
 165

Export Sales: Amcel Co., Inc., and Pan Amcel Co., Inc., 180 Madison Avenue, New York 16, N. Y.

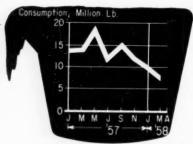
See Chemical Materials Catalog and Chemical Week Buyers' Guide for complete listing of Celanese Chemical Products.



STEEL producers, looking past this recession, spend big for process development.



COPPER industry, especially sensitive to economic cycles, seeks government help.



NICKEL producers suddenly find they now have to fight for customers.

ment of new low-cost processes.

Direct Iron Reduction — Of particular interest to chemical engineers is the search for methods to reduce iron ore directly. The ideal direct-reduction process would substitute a single step for today's costly

combination of coke oven, blast furnace and open hearth.

Several routes competing for attention: Gaseous reduction in a fluid bed (H-iron, Nu-iron, et al); reduction with solid carbonaceous material in a rotary kiln (R-N and Krupp Renn processes); prereduction in a rotary kiln plus further reduction in a submerged-arc electric furnace (Strategic-Koppers).

Much further along is the oxygen-conversion process for producing steel from pig iron and scrap. In this process, which takes place in a furnace resembling a Bessemer converter, a jet of high-purity oxygen is directed at the surface of the molten charge.

Industry reports indicate that, with oxygen conversion, investment per annual ingot ton is cut to about \$15, compared with an estimated \$40/annual-ton for new open-hearth furnaces.

Another idea calculated to cut costs is continuous casting of blooms. Present practice is to cast steel into box-shaped ingots; these ingots are rolled into blooms or slabs as the first step in producting steel shapes. Continuous casting would produce blooms or slabs directly, eliminating the ingot stage.

► Volatile Veterans — Accustomed as it is to buffeting of economic cycles, that veteran nonferrous trio—copper, lead and zinc—has had especially rough going lately. Producers' annual reports for 1957 unanimously reflect effects of oversupply, curtailed operations, reduced prices, slashed earnings.

Domestic copper prices today are only half of their levels two years ago (23-25¢ vs. 46¢). Lead and zinc prices are also down, although by somewhat smaller percentages.

These industries are especially sensitive to supplydemand relationships. Even a slight shortage sends prices up, and a slight oversupply has just as drastic an effect in the other direction.

When prices are high, marginal producers come in and add to world supply. When they can't sell all they make, they start cutting prices, and so the cycle is reversed. Since most of these fluctuations originate

abroad, U. S. producers of copper, lead and zinc have been pressuring the government for increased tariff protection in order to achieve greater stability in domestic operations.

American copper producers, says an industry spokesman, are mining the lowest-grade ore and paying the highest wages in the world. Costs of some U. S. copper operations are said to have increased 500% in the last 20 years, despite such cost-cutting measures as blasting with fertilizer-grade ammonium nitrate.

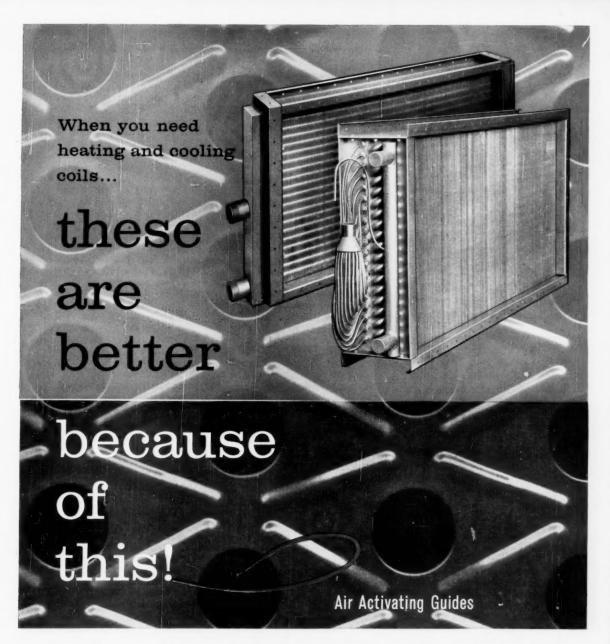
Government is obliged to do something, producers feel, because it encouraged Cu-Pb-Zn expansion in the first place in order to provide adequate supplies for defense needs. But government officials don't seem to be able to agree on just what to do, probably hoping that demand will soon turn up to solve supply and price problems without need for artificial controls that might antagonize some of our foreign friends.

▶ Helping Themselves—The copper industry is going ahead with its own program to answer the oversupply problem — market development. Painfully aware of the aluminum industry's outstanding success in promoting new uses, copper producers are fighting back to snare a bigger share of the nation's spending for housing, electronic devices and process equipment.

The lead industry looks to new markets for improved redlead paint in shipbuilding and highway-construction programs, for lead in rocket-fuel modifiers, for lead compounds in ceramic applications such as procelain enamels.

► Aluminum Resists Slump— Although aluminum faltered last year in an upward climb, its stable price structure has helped keep earnings at respectable levels.

This is not to imply that aluminum producers are having it easy. Potlines have been taken out of service. Entire plants have been shut down. Expansion programs already under way have been delayed. The first price break in 17 years indicates determination to stimulate demand.



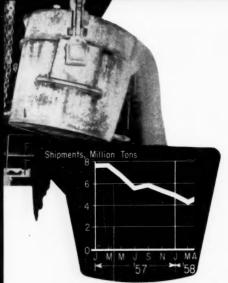


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TITANIUM, in trouble even before the recession, pins hopes on new technology.



ALUMINUM growth stalls temporarily in the midst of a remarkable climb.

On the positive side, aluminum seems to have a good grip on its markets. Declining prices of copper and zinc haven't helped those metals recapture former markets now dominated by aluminum. Substantial long-term growth of aluminum appears certain, with plentiful supply to encourage invasion of new markets, such as cans for lube oils and cheese, large structural shapes and powder metallurgy.

metallurgy.

Nickel Woos Customers—
While increasing nickel supplies have finally caught up with, and exceeded, demand, nickel's price is stable and present markets seem steadfast. Substantial capacity-expansion programs continue to move along in Manitoba and Cuba on the premise that future demands will be developed at a suitable pace.

To develop this demand the

nickel industry must put itself in the peculiar position of seeking customers. Consumption of nickel has been throttled in recent years because of inadequate supplies. One expert estimates that 40% more Ni would have been used if metallurgists had not been discouraged by recurring shortages.

However, nickel salesmen have plenty to work on. Tomorrow's military and industrial technology will call for more structural materials with strength, stability and corrosion resistance at high temperatures. At the other extreme, developments in cryogenics call for alloys with good low-temperature properties. Nickel is the No. 1 alloying ingredient for both ends of the thermal spectrum.

Other growth fields include magnetic alloys for electronic uses, and catalysts for chemical and petroleum processing.

► Titanium Tumbles—Gloomiest spot in the metals picture today is the titanium industry. Last year saw the props literally knocked out from under titanium production.

Titanium's spectacular growth over the period 1950-56 was stimulated entirely by military aircraft demands. Government contracts required 90% of production set aside for government purchase. In actuality, the government has taken nearly 100% of output. Jet engines took 70%, with the balance going into airframes.

What has happened to this market? One answer to this question is purely economic. Since early last year, the government has stretched out or trimmed its programs for production of manned aircraft in order to channel limited available funds into the missile program. A corollary of the defense budget squeeze: Military planners are looking more critically at cost of titanium and permitting use only where its advantages clearly justify its high price. (Increased availability of nickel doesn't help Ti, either).

► Engines Are Too Hot— Another factor is technological. Titanium's strength - weight ratio—big selling point in jet engine use—loses most of its advantage over high-alloy steels when temperatures climb past the 800-900 F. range. Latest engine designs call for operating temperatures well over 1,000 F., rendering Ti practically obsolete for this service.

The titanium slump has had its economic repercussions. Cramet is apparently going out of business, will turn its government-backed sponge plant over to Uncle Sam. Dow's plant is down completely. Other sponge producers are operating at greatly reduced capacities.

Sponge price tumbled another 50¢ last year, is now down to \$2.25/lb.—a far cry from its original \$5/lb. level. Prices of mill products are being slashed, too, in efforts to convince the Air Force that titanium belongs.

Brighter Outlook — Despite today's glut of titanium, the industry has its share of confirmed optimists. Some look for demand to catch up to supply in two years, others say five.

• Titanium stands to cash in on its strength-weight advantage in the missile field. As missile speeds get into the thousands of mph., missile-airframe temperatures will get into the hundreds of degrees. So yesterday's jet engine metal may be tomorrow's missile airframe.

· Despite cutbacks on some research programs, producers are improving technology all along the line, from ore to fabricated products. They are getting more output per dollar of invested capital; they are getting higher yields of specification metal; they are finding ways to reprocess scrap. Even without any major breakthroughs, costs will continue to fall, probably to \$1.50/lb, of sponge by 1962. Lower prices will open up much bigger markets in commercial aircraft.

• Titanium is beginning to prove its real value as a corrosion-resistant material of construction. Producers are pressing for increased sales to the chemical process and marine-equipment industries. Noteworthy is Freeport Sulphur's order of seven miles of seamless Ti tubing for its new nickel-cobalt ore-concentration plant at Moa Bay, Cuba.

protected from fungal decay

NOW ... and for years ahead

1959 1960

1958

1961

1962

1963

1964

AND MORE



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All of the 1,715,000 board feet of lumber used in constructing the mammoth Clinch River Station cooling towers of the Appalachian Power Company at Carbo, Va., was pressure-treated with Koppers chemical preservatives to protect it against the development of fungal decay, the most frequent cause of early tower failures. Koppers pressure-treatment was specified for this important installation, because Koppers methods and preservatives assure tower lumber a maintenance-free life expectancy many times longer than that of untreated redwood.

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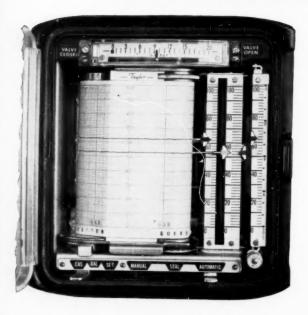
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Taylor's
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The Taylor TRANSCOPE Controller and Recorder are companion plug-in instruments. Together they give new standards of process control performance... unprecedented stability, accuracy and adaptability. Especially suited for the short spans of measurement encoun-



tered in present day processing. The TRANSCOPE Controller is insensitive to ambient temperatures, and highly resistant to mechanical shock. Write for Bulletin 98278.

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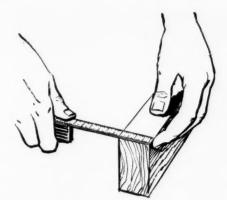
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YES! DIMENSION and QUALITY of redwood are the obvious and fundamental cornerstones on which long service life and low maintenance costs must rest. They are your ONLY protection against <u>delignification</u> or <u>chemical attack</u>! Coupled with proper wood preserving treatment, they provide the necessary safeguards even in those areas where <u>biological attack</u> is prevalent.

COMPARE WHEN YOU BUY — AND INSIST ON GETTING THESE FOSTER WHEELER STANDARDS

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FILL DECK SUPPORTS	2"	1"	1/2"
WATER DISTRIBUTION SYSTEM	2"	1"	1"
FAN STACK SHEATHING	11/2"	1"	%" S
AIR INLET LOUVERS	1"	%" ===	1/2"
DRIFT ELIMINATOR BLADES	1/16"	1/16"	5/16"

"To conserve water is good business . . . for you, your neighbor, and the Nation."



FOSTER WHEELER







Pick any four, plug in, and record

Here is a receiver recorder, custom-built by you to meet your needs, no matter how changeable, how complex. On a single chart you can record any four measured variables—and interchangeable receivers permit new combinations almost at will.

Individual plug-in pneumatic or electronic receivers—and corresponding integrators—are interchangeable in the four identical frame slots. You can select any combination; even including two receivers and their two integrators.

Think what this can mean to you! Parts inventories are minimized; re-use of components keeps instrumentation costs economically low when cycle changes are frequent—and you can even tie in with your existing transmitters.

Ask for Product Specification E12-5.

% combustibles combustion conductivity density differential draft flow liquid level % oxygen PH position pressure ratio smoke density specific gravity speed temperature vacuum

PRR. 1

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- Pre-calibrated plug-in receiver units
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- Any four variables on one chart—easily read and interpreted
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- Faster ordering—from stock
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- Minimum instrument investment for process cycle expansion or alteration



1037 IVANHOE ROAD

Controls for Power and Process



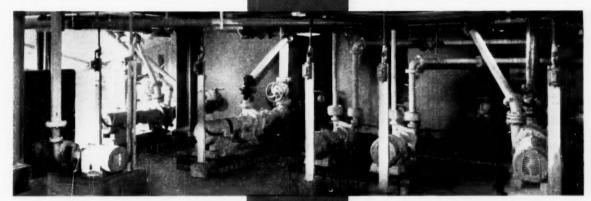
Controls for TEMPERATURE

PRESSURE
GAS ANALYSIS
FLOW LEVEL
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WILFLEY

ACID PUMPS

HANDLING CONCENTRATED PHOSPHORIC ACID IN THIS NEW 200,000 ton-per-year triple super-phosphate plant



Wilfley Acid Pumps are a key factor in the successful operation of this largest single-stream phosphoric acid reaction system ever built. These famous pumps were chosen for their lower maintenance costs and continuous, trouble-free operation.

Individual Engineering on Every Application

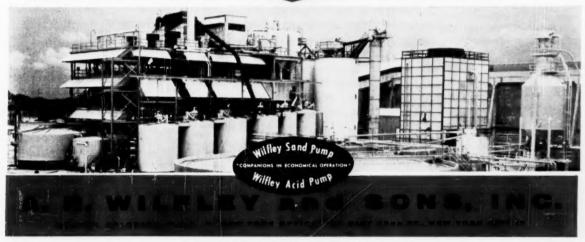
DESIGNED AND ENGINEERED BY DORR-OLIVER INC.

Whenever you have a pumping job that calls for high quality Acid Pumps with built-in economy, check with Wilfley.

Wilfley Acid Pumps are available with pumping parts of the machinable alloys as well as plastic to meet all requirements.

Write, wire or phone for complete details.

FOR AMERICAN CYNAMID COMPANY





News about COATINGS for METALS

Metallic...... Organic...... Decorative...... Protective

Improved phenolic linings extend tank life

Plastisol gives tank exteriors "lifetime" protection

Serious tank corrosion often occurs from the outside in. Solution spillage and corrosive atmospheres can deteriorate ordinary coatings and attack the metal, shorten equipment life.

ELIMINATES MAINTENANCE

Protecting the exterior of tanks and equipment with Unichrome "Super 5300" Plastisol is good practice, good economy. Especially so where maintenance is difficult. For this same material that is protecting so many tank interiors makes exteriors corrosion resistant, too. One application usually gives lifetime protection. Non-porous and seamless, this vinyl shield stops corrosive fluids and fumes.

CAN BE PATCHED

Its flexibility and toughness help prevent impact and abrasion damage. Should patching ever become necessary, Unichrome "Super 5300" can be sprayed on, spot baked, and protection restored good as ever.

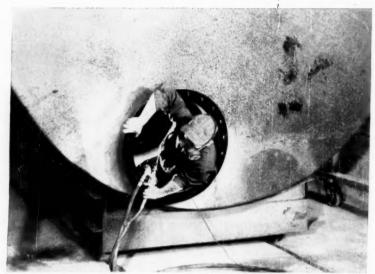
See details in your copy of "CEC", or send for Bulletin Chem C-3.



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Specialists are located in key areas to apply Unichrome Phenolic Linings. They have the experience and the facilities to handle even large, difficult jobs promptly and properties.

Photo Courtesy General Coating Co., Woodbridge, N.J.

Unichrome B-124 Linings have increased resistance to impact, give thicker films, positive cure-control

Phenolic coatings continue to provide a most economical lining for tanks, tank cars, drums. Features have been incorporated into the Unichrome Series B-124 phenolics that greatly improve the physical properties...increasing their reliability still further for corrosive service,

WON'T CHIP ON IMPACT

Improved reverse impact resistance of Unichrome phenolic linings is especially valuable in containers and tanks subject to handling abuses. Linings stick

tight, prevent exposure of metal, guard against corrosion and contamination of the product.

SPECIAL FEATURES

Unichrome Series B-124 Linings include materials that bake to a hard, glossy surface for an easy-to-clean final coat; others go on as thick as two mils per coat — twice that of ordinary phenolics; still another signals with a visible color change when fully cured, to assure optimum durability.

Unichrome B-124 Coatings stand up in direct contact with wide range of active materials, including strong acids and solvents. Write Metal & Thermit for information and names of nearby applicators that can give you fast service even on large equipment.

Open pumped tube unit permits easy access for inspection, Easy to recondition in field.



Mercury Arc

Rectifiers

Pumped or Sealed? Open or Enclosed?

Here's how Allis-Chalmers can help you choose a rectifier for your job—

BOTH sealed and pump-evacuated tube rectifiers offer distinct advantages, depending upon the application. Whether your rectifier should be open or enclosed construction also depends on the application. Since Allis-Chalmers offers you a choice of sealed or pumped

tubes in either open or enclosed construction, you get an unbiased recommendation, based on a study of your needs, and not on commercial expediency. And you can be sure of unsurpassed reliability and ease of operation, as proved in hundreds of Allis-Chalmers installations.

Only Allis-Chalmers Excitron Rectifiers give you all these important advantages—

- Fixed excitation anode does not contact mercury — is independent of level, turbulence or impurities.
- Continuous excitation eliminates need for reignition pilot arc always present.
- Grid phase control located in clean region near anode where ion density is lowest.
- Internal cooling system provides high heat transfer with seamless tube coil.
- Arc-over-free tube eliminates arc-over danger by insulating entire arc path.
- Enameled anode seals provide high strength, trouble-free seal.

For detailed information on mercury arc rectifiers contact your nearest A-C office, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin, for bulletin 12B8494.

ALLIS-CHALMERS



PRACTICE ...

PROCESS FLOWSHEET C. H. CHILTON

Here's our engineering report to you on the three latest types of nuclear power reactors, another in CE's succession of articles* keeping you informed of developments in this growing field.



Sodium Reactor Experiment

. . . points out sodium's excellent heat-transfer properties as a successful reactor collant.



Organic Moderated Reactor Experiment

. . . reveals the merits of noncorrosive terphenyl in its dual role as reactor collant and moderator.



Pressurized Water Reactor (Shippingport)

... displays the advantages of water as coolant and moderator in operating a full-scale power reactor.

- Sodium
- Terphenyl
- Water

Vie for Role as Reactor Coolant

THE FREE world has made great progress toward the development of commercial nuclear power. Within the last eleven months three key power reactors, representing three different basic types, went into operation.

Calder Hall, the world's first commercial-scale reactor, employs carbon dioxide as coolant and graphite as moderator. This British development takes advantage of CO₂'s noncorrosive properties and the favorable economics of using cheap natural uranium fuel. On the minus

side is the reactor's built-in limitation; because of the tremendous amount of fuel necessary to get its present power output, further upscaling seems unlikely.

Argonne National Laboratory's boiling-water reactor requires no intermediate heat exchanger to produce steam for turbogenerator peration; steam produced in the coolant loop is used to drive the turbo-generator. This, however, permits the carryover of radioactive material to the steam equipment.

Atomics International's sodium reactor experiment (SRE) highlights the use of sodium as coolant and graphite as moderator. Sodium's excellent heat-transfer properties, high boiling point, low melting point justify its use.

Organic-moderated reactor experiment (OMRE), also built by Atomics International, uses terphenyl both as coolant and moderator. Terphenyl's noncorrosiveness and high boiling point render it particularly favorable as a coolant.

Shippingport's pressurized-water reactor (PWR), built by Westinghouse and Duquesne Light Co., employs water as both coolant and moderator. Water, with its excellent heat-transfer properties, is pressurized to 2,000 psi.

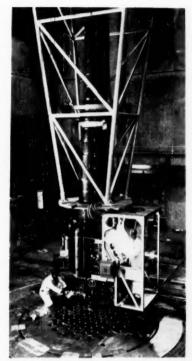
Calder Hall gas-cooled reactor (Chem. Eng.. Dec. 1956, pp. 114-116). Argonne National Laboratory boiling-water reactor (Chem. Eng., Aug. 1957, pp. 239-233)

Unfold Flowsheet

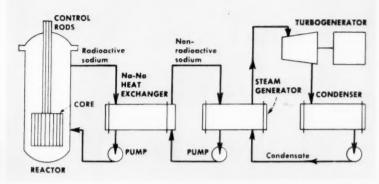




Sodium Reactor Experiment

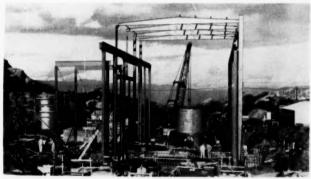


REACTOR FUEL is installed by lowering elements through shield plugs.



MODERATOR AND REFLECTOR are installed in core.





CORE CONTAINER which houses "reactor heart" is put in position.

Los Angeles by Atomics International (division of North American Aviation), SRE was the first U.S. nonmilitary reactor to produce power for generating commercially distributed electricity. The plant began producing power last July and just last month reached and exceeded its design capacity of 20,000 thermal kw. Heat is converted to 6,500 electrical kw.

Heart of the SRE is the thermal, heterogeneous, enriched-uranium-fueled reactor. Reactor heat is transferred to sodium coolant, heating it from 500 to 960 F. Heated sodium from the reactor's coolant channels is radioactive, therefore unsafe to handle; it yields its heat

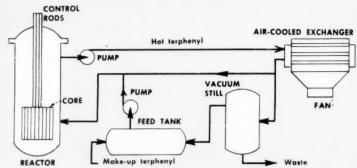
via a primary heat exchanger to a second, nonradioactive sodium stream, heated thereby from 440 to 900 F. The second sodium stream cycles to another heat exchanger to uroduce 600-psi. steam.

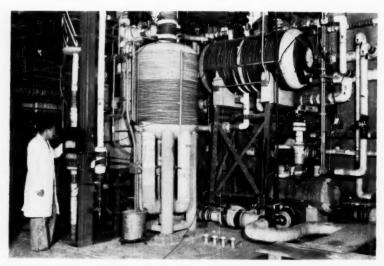
Shielded by an outer tank and contained in a core tank, the 6-ft.-high, 6-ft.-dia. reactor core is the origin of the SRE's power. Core consists of 47 zirconium, cylindershaped cans of graphite moderator and 72 of reflector. There are 43 channels between cans that house fuel elements when the reactor is putting out rated power. Fuel elements are 6-ft.-long stainless steel jackets enclosing sealed and bonded slugs of enriched uranium fuel (2.8% U-235). Each of four control

elements consist of a column of boro-nickel rings assembled on a tube extending from the top shield of the reactor into corner channels of the core.

Sodium coolant flows through channels in the moderator cans. Electrical heaters on thermally insulated pipe prevent solidification of sodium. Sodium leak detectors linked to the reactor control panel assure safety in handling. Pumps are modified centrifugal pumps with frozen-sodium shaft seals (Chem. Eng., Mar. 1956, p. 124). Cold and hot traps remove sodium oxide from the primary sodium cycle, hence eliminating fouling in the channels through moderator cans.

Organic Moderated Reactor Experiment





VACUUM STILL purifies terphenyl reactor coolant by flashing off its high-boiling vapors and discharging decomposed matter as waste.



REACTOR VESSEL is installed.

At the National Reactor Testing Station (Arco, Idaho) OMRE, designed and constructed by Atomics International, went into operation last September. Built to collect data and not to deliver useful power, the unit rejects 12,000 thermal kw. to the atmosphere via an air-cooled heat exchanger. OMRE is part of the program leading to the construction of the Organic Moderated Reactor (OMR), a full-scale power plant slated to furnish Piqua, Ohio, with 11,400 ekw.

Containing the power-generating core is a 4½-ft.-dia., 28-ft.-tall reactor vessel. Terphenyl coolant, circulating at 7,200 gpm. through the reactor core, is heated from 500 to 700 F. Hot terphenyl is piped to

the air-cooled heat exchanger, where it gives up heat to the atmosphere. A bypass purification system removes any hydrocarbon coolant broken down by the high-temperature operating cycle.

Simple design of reactor core is due to triple role of terphenyl as coolant, moderator and reflector; fuel elements and control rods surrounded by coolant make up the core. Fuel elements, 25 in number, having a total U-235 content of 20.6 kg., are of the plate type. Each fuel element is assembled from 16 stainless steel-uranium dioxide plates, separated by a 134-mil coolant gap, and supported by end boxes positioned in upper and lower grids. Plates consist of a 20-mil-

thick central portion of enriched UO₂ clad with stainless steel.

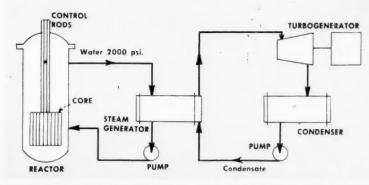
Terphenyl has been selected as coolant because of its minimum radiation absorption and decomposition. Low-pressure batch distillation (30 mm. Hg) maintains the proper purity level in the terphenyl coolant cycle. Only 1.5% per day of total hydrocarbon charge of the OMRE need be bypassed to the purification system. A second bypass loop equipped with instruments continuously measures and records heat-transfer data as the reactor operates.

Test runs measuring operational characteristics have been successfully completed at powers up to 12,000 tkw.

Pressurized Water Reactor (Shippingport)



UNDERGROUND CHAMBER shields pipes containing pressurized water.





VESSEL is lowered into enclosure.



FUEL is placed in pressure vessel.

EDICATED last month after five months of successful operation, the Shippingport PWR is U.S.'s first large-scale nuclear power reactor. Contracted by Westinghouse and Duquesne Light Co., the reactor produces 231,000 thermal kw. which is converted to 68,-000 electrical kw.

Heat produced in PWR's enriched-uranium-fueled reactor core is removed by 2,000-psi, pressurized-water flowing at 56,400 gpm. through three of four loops. Water is thus heated from 508 to 538 F. Each loop consists of channels through reactor core, 18-in, stainless steel piping from reactor, a heat exchanger and a vertical, single-stage, centrifugal pump.

Two types of heat exchangers, straight tube and U-bend, are used to generate steam. Both types are equipped with Type 304 stainless steel tubes, steam separators and dryers. An 18-ft.-high, 5-ft.-dia. pressurizing tank maintains constant operating pressure in the coolant cycle by means of a 146-cu.-ft. steam-filled space at the top of the

Source of plant's power is 145 fuel assemblies contained in a core cage within the reactor's 321-ft.high, 10½-ft.-dia., concrete and steel-shielded pressure vessel. Core cage is a cylindrical, hollow barrel with a grid top, through which fuel assemblies are inserted. Fuel charge weighs 58 tons.

Blanket fuel assemblies, 113 in number, are enriched with 198 lb. of U-235. Each blanket assembly is made up of 120 Zircaloy-2 tubes filled with 10-in.-long uranium dioxide pellets. The remaining 32 assemblies, called seed assemblies, contain 165 lb. of U-235. Each seed assembly consists of a 110-in.-long, 5½-in.-sq. arrangement of zirconium-uranium alloy plates, clad with Zircaloy-2, vertically mounted and separated by coolant-flow spaces. A hold-down barrel resting on the core cage counteracts upward hydraulic thrust of water flowing up through the core cage. This complicated seed-blanket core design was selected because of its minimal U-235 content.

Kathabar® systems eliminate

wet floors, walls, equipment, and products!



Think what it would mean to you if you could eliminate condensation and its corrosion problems from plant processing and storage areas, and keep work spaces dry even when they're hosed down regularly for sanitation.

Maintenance savings alone would improve your profit picture for the year. Increased life of your structures and equipment would pay long-term dividends. Storage losses from condensation would be a thing of the past.

Such profits are immediately available to you in a Kathabar-engineered air conditioning system.

let's look at cases

This sampling of Kathabar installations will show you how effective and versatile a Kathabar system can be.

waterworks case

Pipe galleries in a huge waterworks are completely surrounded by water as cold as 40 F. A Kathabar system maintains the air at below the water dew point, year-round, and eliminates condensation. This system paid for itself in less than three years.

brewery case

In the new cellars of a large midwestern brewery, a Kathabar system is earning profits by elimating condensation. Washdowns are less frequent; dry cellars curb bacterial growth. As a bonus benefit, the Kathabar system delivers the air at a maximum count of 4 Berratia Mercescens per cubic foot when the air entering the unit contains 40.

candy case

A candy manufacturer was plagued by condensation on the cooling slabs in his enrobing room. The moisture made his conveyor belt expand and jam. Chocolate and starch dust gummed up the belt and stopped production. A Kathabar system not only eliminated these problems, but increased production by 25%.

marine case

Kathabar systems in cargo ships and tankers provide anti-corrosion control, protection against cargo contamination, and ready gas freeing of all tanks. Kathabar systems quickly amortize themselves in maintenance savings, longer bulk-head life, better cargo protection, and faster turn-around.

other cases

Consulting engineers combine radiant panel cooling with Kathabar systems to dehumidify fresh air makeup. Colder water can be used in the panels, increasing efficiency without the danger of condensation.

Unitized Kathabar systems, using only electric power, dehumidify government storage caves. Completely portable, they are readily spotted to keep the dampest areas bone dry. Individual units avoid the fire hazard of a central system.

who uses Kathabar systems

Atomic Energy

Gelatin

Glass

Kathabar systems make profits out of air for these industries:

Machining

Breweries Marine Cake Mix Matches Candy Meat Cellophane Offices Cellulose Ordnance Cereals Paper Chemicals Pharmaceuticals Coffee **Plastics** Comfort Printing Compressors Rockets Cookies Rubber Electronics Sanitaryware Explosives Shellac Film Sugar **Foundries** Testing

Glue Transistors
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Textiles

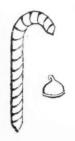
Transformers

Lacquer Wire Lenses Yeast

how they use Kathabar systems

Many of these industries use Kathabar systems for eliminating condensation. Others use them to (1) obtain continuous air at sub-freezing dry bulb and dew points; (2) maintain spaces below 80 F and 55% RH; (3) maintain spaces at specific low bacteria or mold count; and (4) improve drying processes.

send description of your problem
Air Conditioning and Drying Division
SURFACE COMBUSTION CORPORATION
2380 Dorr Street Toledo, Ohio







Kathabar systems by



Case Report on "Craneloy 20" Gate at D-X Sunray Refinery



Best valve performance ever on toughest acid service . . .

... So says the D-X Sunray Oil Co. about this "Craneloy 20" gate on sludge draw-off at the big West Tulsa refinery.

Installed at the agitator bottom, this 6-inch Crane valve is handling various hot sulphuric acid sludge mixtures—concentrated and weak—

steam-diluted to as low as 30%.

Valves used previously had to be replaced every 3 to 6 months. But this "Craneloy 20" gate went a full 14 months before minor repairs—then was put right back into service. It has the best record of any valve used on this toughest job in the refinery.

Specially developed for sulphuric acid at elevated temperatures, "Craneloy 20" is a high-nickel, high-chromium stainless. Teamed with Crane split-wedge, rotating-disc seating design, it makes a valve no corrosive fluid processor can afford to overlook for truly low-cost flow control.



GET FULL FACTS on "Craneloy 20" and other Crane quality alloy valves and fittings. Ask your Crane Representative for Circular AD-2080, or write to address below,

CRANE VALVES & FITTINGS

PIPE . PLUMBING . KITCHENS . HEATING . AIR CONDITIONING

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CHEMICAL ENGINEERING-June 30, 1958

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In these rough times, you need to take advantage of every possible saving to hold profit margins.

Raymond Mills with Flash Drying Accessories offer multiple economies in the production of powdered materials. The operations are combined in a single unit system, thus simplifying installation, saving time in handling materials, reducing cost of overhead and maintenance.

Drying the fine particles is instantaneous, and the product is closely controlled in fineness and moisture content. Heat sensitive materials are safely handled, and their quality maintained for meeting maximum specifications.

For processing chemicals, pigments, filter cake, clays, industrial wastes and special products . . . the Raymond Flash Drying System is available with different types of Mills to fit your job.

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Tell us your requirements, and Raymond Bulletins will be sent you, describing recommended equipment.

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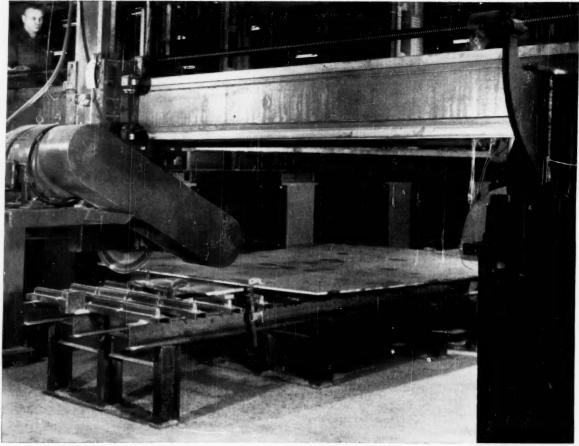
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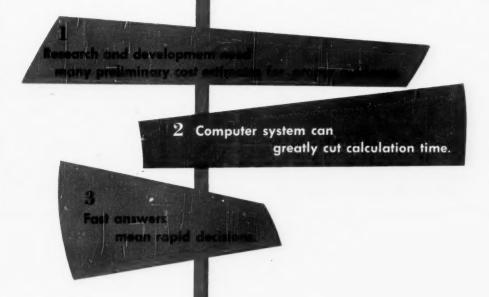
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Computer Speeds Economic Evaluations

J. F. ADAYS, W. L. MASSEY, JR. and M. DMYTRYSZYN Monsant Chemical Co., St. Louis, Mo.

Recently a comprehensive scheme for carrying out preliminary or screening-type economic evaluations has been developed within the Research Dept., Organic Chamicals Div., of Monsanto Chemical. This estimating scheme appears to satisfy the two cardinal requirements for schemeing-type evaluations: speed and reasonable accuracy.

as been achieved by program-Speed y of the routine calculations ming n ion on an IBM 702 EDPM. for exe This pr ram not only derives a large amount information from a nominal amount input data, but provides all report format on Multilith output masters uitable for duplication and ina report. Thus, not only is the sertion burden calculation and report presentation uced for the estimator; but there a very significant saving in stenogr hic time and in proofreading, etc.

A comparison of research estimates produced by this estimating scheme against actual performance data, or against subsequent appropriation-grade estimates made elsewhere, has revealed good agreement in most cases. A continuing analysis of feed-back data will permit additional improvement through the years.

More Time for Detailed Estimates

Appropriation-grade economic evaluations are prepared for one or at most only a few specific situations. Generally they are prepared from data obtained in a completed research program, which probably will have included a pilot plant demonstration and/or actual plant operation in interim facilities.

The proposed plant will be designed for a specified annual volume, and expected market price will be fairly well established. Such evaluations must properly be made with great care. Generally, the volume of repetitive calculations will be small, but much time must be spent in preparing material balances, sizing of equipment, making a firm capital estimate, etc. A comparatively modest number of such detailed estimates will be prepared annually, and usually a matter of

Meet our authors on p. 138. This article is based on paper delivered at the June 16-18, 1958 sec annual meeting, American Assn. of Cost En ers, in Cleveland, Ohio.

Nomenclature

All other working capital, \$	F	Exponent (describes variation in total conver- sion cost with plant size).
	FC	Fixed capital, \$
Exponent (describes variation of total plant cost with plant size).	FCBU	Back-up capital from intermediates, etc., \$ Fixed capital for finished product, \$
Back-up capital, \$/annual lb. (for captive inter- mediates).	FCFPE FCFPN	Fixed capital for finished product, existing, \$ Fixed capital for finished product, new, \$
Capital dependent on sales, \$/annual lb. (includes working capital and sometimes in-	IF	Inventory factor (permitting variation of raw materials and finished product inventory;
ventories, if estimated as percentage of sales).		1 = one month's supply of the raw materials plus one month's output of the finished prod-
Capital independent of sales, \$/annual lb.	INWC	uct). Inventories, \$ (including raw materials, in-
	INVIC	process, and finished goods).
	INWCP	Inventories (including intermediates, raw ma-
Total conversion cost for basic case (direct plus indirect), \$/cwt. finished product.		terials, in-process, and finished goods; back- up factors must not contain any inventory
Earnings (before taxes), \$/yr.		component if inventories estimated using
Efficiency factor (a factor which takes into ac-		this factor).
count inefficiencies due to intermittent manu- facture).	17	Federal corporate income tax rate, % (a value of 0% is "built in" in the computer program
Equipment index number (used to correct for variation in equipment costs with time).		so that earnings and returns on investment will be on a before tax basis).
	All other working capital, % of annual dollar sales. Exponent (describes variation of total plant cost with plant size). Back-up capital, \$/annual lb. (for captive intermediates). Capital dependent on sales, \$/annual lb. (includes working capital and sometimes inventories, if estimated as percentage of sales). Capital independent of sales, \$/annual lb. (fixed capital, inventories, etc.). Total conversion cost (direct plus indirect), \$/cwt. finished product. Total conversion cost for basic case (direct plus indirect), \$/cwt. finished product. Earnings (before taxes), \$/yr. Efficiency factor (a factor which takes into account inefficiencies due to intermittent manufacture). Equipment index number (used to correct for	All other working capital, % of annual dollar sales. Exponent (describes variation of total plant cost with plant size). Back-up capital, \$/annual lb. (for captive intermediates). Capital dependent on sales, \$/annual lb. (includes working capital and sometimes inventories, if estimated as percentage of sales). Capital independent of sales, \$/annual lb. (fixed capital, inventories, etc.). Total conversion cost (direct plus indirect), \$/cwt. finished product. Total conversion cost for basic case (direct plus indirect), \$/cwt. finished product. Earnings (before taxes), \$/yr. Efficiency factor (a factor which takes into account inefficiencies due to intermittent manufacture). Equipment index number (used to correct for

several weeks or months will be required for preparation of each estimate.

Speed Is Vital in Research Evaluations

For preliminary or screening estimates, particularly those for the guidance of research and development activities, the problems to be faced are considerably different. First the number of estimates will be much greater, since it is usually desired to make an evaluation of some sort on most research projects. Only those which show a high probability of commercialization, however, become the subject of an appropriation-grade evaluation. Secondly, speed in evaluation is of great importance. Inquiries from outsiders must be ans vered quickly; evaluations may also be requested to g e the course of research work currently in progress—what experiment to run next, for instance.

It is not uncommon to carry out several evaluations on the same product as a project progresses through several phases of development.

In short, any system for providing evaluations for the type of research done in our Organic Division laboratories must provide quick answers.

Another special characteristic of preliminary economic evaluations is that they must be based upon incomplete data, since in most cases these evaluations are made on developments which are still in the laboratory or pilot plant phase.

It is often not known what the ultimate yield on important raw materials will be, or in some instances, which one of several possible processes will be used. Frequently it's necessary to set up evaluations so the answers will show effect of yield, point out the most economic process, etc. It sometimes may be necessary to decide, on the basis of another preliminary evaluation, whether Monsanto should make or buy one of the major raw materials for a new product.

Evaluations Must Cover Wide Range

Still another distinguishing feature of preliminary economic evaluations for research guidance: In almost

every instance it is desirable to prepare estimates for a wide range of annual production volumes, ranging perhaps from small spot runs in interim facilities to the hypothetical situation in which a new plant is built to produce the new product in sizeable volume (generally in the multi-million lb./yr. range). Request for a survey of the economics of manufacture over a wide range of volume is so often asked that it has become standard practice to provide the information in evaluations, even if not requested, since the question almost certainly will be asked eventually.

Preliminary or screening-type economic evaluations as carried out for research guidance also differ from the usual engineering appropriation-grade evaluation in that the desired end-product is different. In the usual evaluation the end-product is the calculated return on investment for a plant to manufacture Compound X at the rate of Y lb./yr. (annual divisor). The end-product in research evaluations is estimated selling price versus return on investment relationship. This comes about because in many instances no market price has been established for the new product under consideration.

Estimated selling prices are of great interest for new products, since the required selling price may determine whether a new product will have utility in a certain field. The relationship of selling price to annual divisor is also of considerable importance, as such estimates frequently contain the only information available on which to base price quotations for development quantities. Also, since developmental prices are always high, estimated ultimate pricing at large volume is of considerable interest.

To summarize, an extensive and diversified research program requires a large number of economic evaluations each year. Output data are most useful if obtained in the form of a selling price versus return on investment relationship.

In these evaluations it is generally necessary to include a relatively wide range of annual divisors. In addition, the large number of unresolved problems existing at an early stage of a new development frequently calls for inclusion of other parameters, along

LF	Lang factor (ratio of total plant cost to pur- chased, delivered, or installed cost of major equipment items).
MC	Manufacturing cost, \$/lb. of finished product.
MCCWT	Manufacturing cost, \$/cwt. of finished product.
MECHC	Mechanical alterations costs, \$/cwt. finished product.
MECHT	Mechanical alterations costs (total for spot run), \$
MIFC	Purchased or installed value of major equip- ment items.
PCB	Production capacity for the basic case, lbs. finished product per yr.
PR	Production rate, lb./mo.
Q	Sum of all items of working capital which are expressed as a percentage of annual dollar sales of finished product, % (SAREWCP + AOWCP + INWCP)
RETP	Return on total fixed and working capital. (Since a tax rate of 0% is included in computer program, return values are on a before tax basis).
RMC	Raw material cost, \$/cwt. finished product.

Sales rate, lb./yr., or amount produced in spot run. SARFF Sales, administrative, research, and engineering expense, \$/lb. SAREP Sales, adm., res., and eng. expense, % of dollar annual sales. SAREWC Sales, adm., res., and eng. capital (misc. fixed investment, allocated in some cases as % of dollar annual sales), \$ SAREWCP Sales, adm., res., and eng. capital, % of annual dollar sales. Selling price, \$/lb.
Total fixed plus working capital, \$ TFWC LIND Unit price, \$/unit. Usage, units/cwt. of finished product. USG

The computer program has been set up to give values of earnings, etc. on a before tax basis. This has been accomplished by use of a value of 0% for the corporate income tax rate. A change in the value of 17 in the program, plus alterations on the printout sheet, will permit calculation at any desired tax rate.

Working capital, \$

with the usual parameter of divisor. Thus on occasion a large number of situations or "cases" must be evaluated to give adequate treatment to the problem.

A rapid yet comprehensive scheme for preliminary economic evaluations has been devised to fit the needs of a commercial chemical research organization and is described here.

Approach To Preliminary Economic Evaluations

Our approach to preliminary economic evaluations has been to derive the selling price-return relationship for a number of specific cases,

Once the numerical data are available, it is then possible to plot the data graphically to illustrate pertinent points. For example, the data might be used to calculate the variation in calculated selling price with annual divisor. Or, a family of curves can be plotted on the same chart with return on investment as a parameter. Or, a comparison between alternate processes can be presented side by side in terms of the selling price and volume. In fact, the amount of data yielded by the preliminary estimating scheme described is so large that the number of forms of presentation possible is limited only by the ingenuity of the estimator.

Data processing via computer has imposed a definite procedure for handling of problems. As a first step each problem of the cost estimate variety is defined in terms of a number of specific situations or cases (see sample problem).

Production bracket is a parameter which is included in every evaluation. The number of other parameters or variables which may be included in virtually limitless. These may include such items as yield on major raw materials, degree of catalyst recovery, process alternate, cost of major raw materials, back-up capital requirements for intermediates produced by captive manufacture, efficiency of solvent recovery, type of packaging, product form, product concentration, and material of construction, just to name a few.

Once the problem has been defined in terms of a number of specific cases, a list of raw materials is prepared which includes usage, unit price, and back-up capital requirements per annual pound (if any).

Enter Concept of the Basic Case

WC

Total conversion cost and fixed capital requirements (for the finished product) are estimated using the concept of the "basic case." A basic case is worked up for each group of cases having all variables in common except production bracket. Conversion costs and fixed capital requirements (in terms of major equipment items required) are estimated for each basic case, which generally corresponds to an easily visualizable scale of operation. Conversion costs and fixed capital requirements for other divisors are then estimated by computer from data for the basic case by application of empirical correlations. Mechanical alteration costs are estimated when appropriate.

Once the master list of raw materials has been assembled, mechanical costs for the appropriate cases estimated and data for the requisite number of basic cases calculated, the balance of the evaluation is completed by the computer. Output data from the computer are inserted as such in the finished report, but are supplemented by a written text and whatever charts and graphs are felt to be necessary for interpretation of data.

Program Has Built-In Flexibility

The computer program as set up is quite flexible, allowing the estimator considerable freedom.

An estimator can in most instances indicate how the various derived quantities are to be calculated. For example, inventories can be computed by two different methods; or a numerical value can be inserted if some unusual situation is encountered which the programmed methods will not handle.

Similarly, in other areas of the computer program, provision has been made for the insertion of numerical input in addition to providing alternate methods for calculation. This has been done deliberately to insure flexibility and to leave the door open for eventual devel-

opment of additional computer routines for more detailed or more accurate estimation of the various

Since input data can be inserted for all important quantities, and any or all of the built in calculation methods by-passed, the computer routine developed for preliminary economic evaluations can be used for any type of economic evaluation. Insertion of more accurate input will result in more accurate output, since the calculation of the selling price-return relationship is rigorous.

The equations for this calculation have been derived algebraically from the standard Monsanto procedure

for calculation of return on investment.

Interestingly enough, several unforeseen advantages of machine computation have become apparent. Repeat calculations are much easier, since usually only a few items of input data must be changed. Secondly, since the possibility of error in the machine calculation is virtually nil, one can have complete confidence in accuracy of the output.

Thirdly, the requirements for programming for computer execution have required reduction of the estimated scheme to writing. A written procedure, it is felt, will serve to standardize evaluations by minimizing the effect of minor differences in technique

between various individuals.

And lastly, the data sheets filled in to provide input for the computer calculation serve as check lists, insuring that pertinent items haven't been omitted from consideration. These latter benefits, although more intangible than the readily perceived advantages of speed and accuracy, are important plus factors for estimation by computer.

Computer Only Understands Mathematics

To program the preliminary evaluation scheme for computer execution, it is necessary to reduce it to written form. This written form is couched in mathematical language, since the computer operation consists primarily of the execution of mathematical operations in sequence.

A system of nomenclature for the various quantities involved has been devised for use in the mathematical equations employed. Since certain of the quantities have become well known in the form of initials, this principle has been applied to yield similar symbols for the various other terms encountered in evaluation work.

Symbols used in the equations which describe the calculations are given in the nomenclature.

First Estimate Raw Material Costs

A master list of raw materials covering all cases is submitted for each problem, each raw material being

coded with a unique number.

For computation every different combination of usage, unit price, and back-up capital factors for a given raw material is assigned a different code number. Hence, the same material might be coded as several different raw materials because of a differing usage figure, etc.

Included in the input data for each case is a list (by code number) of the raw materials used in that particular case. In the machine processing the computer records the master list of raw materials on magnetic tape. Then, in calculating raw materials cost and back-up capital for the individual cases, the computer searches the tape for the necessary data.

Input data for the master list would include name, unit price (UNP), usage (USG), and back-up capital

(CAP). Input data for each case would include a list of raw materials numbers. Then calculations would follow

as below:

$$RMC = RMC_1 + RMC_2 + \ldots + RMC_n \tag{1}$$

$$RMC_1 = USG_1 \times UNP_1, \tag{2}$$

$$RMC_2 = USG_2 \times UNP_2, \text{ etc.}$$
 (3)

Estimating Conversion and Alteration Costs

Total conversion cost (direct + indirect) may be entered into the calculations in three different ways: (1) a value may be calculated by any means desired and entered as input; (2) for interim manufacture, the total conversion cost for various production brackets may be calculated as the product of an efficiency factor times the calculated total conversion cost for a basic case (efficiency factors are usually calculated, but may be estimated by experience for rough estimating); and (3) for larger production brackets in new plants, total conversion costs can also be derived from the calculated value for the basic case by means of an exponential expression.

$$CONC = \text{Input}$$

 $CONC = CONCB \times EF$ (4)

$$CONC = CONCB \times (PCB/S)^{p}$$
 (5)

In certain instances, particularly for small runs in interim facilities, an expense for mechanical alterations will be incurred. This expense is usually written off over the production run, and hence is added in as a component of the manufacturing cost in such situations:

$$MECHC = (MECHT \times 100)/S$$
 (6)

Manufacturing Cost and Capital Calculations

Manufacturing cost in each case is arrived at by addition once the foregoing quantities have been calculated:

$$MCCWT = RMC + CONC + MECHC$$
 (7)

$$MC = (MCCWT)/100 (8)$$

Fixed capital for a product consists of (1) total investment in facilities for the manufacture of the finished product plus (2) back-up capital assignable if intermediates from captive manufacture are used and charged into the manufacture of the finished product at their respective manufacturing costs.

This estimating scheme requires the estimation of back-up capital by the use of unit back-up factors. These factors, when multiplied by the quantity of the intermediate used, will yield the amount of back-up capital assignable to the finished product. Back-up factors may or may not contain an inventory component, depending upon the method to be used for estimation of inventories.

Fixed capital requirements for the finished product are estimated for the basic case using "Lang Factors." In the case of manufacture in existing facilities, investment for short runs is prorated on the basis of time of occupancy.

Sample Calculations for Typical Economic Evaluation Problem

Problem: We want to prepare an economic evaluation for the manufacture of chlorinated Compound Z. Twelve different cases will be considered:

Case	Production Bracket	Plant	Yield on
Case		Location	Compound Z
1	7,260 lb. spot	Interim	60%
2	36,300 "	Interim	60
3	145,000 "	Interim	60
4	363,000 "	Interim	60
5	726,000 lb./yr.	New plant	60
6	2,180,000 "	New plant	60
7	7,260 lb. spot	Interim	80%
8	36,300 "	Interim	80
9	145,000 "	Interim	80
10	363,000 "	Interim	80
11	726,000 lb./yr.	New plant	80
12	2,180,000 "	New plant	80

Raw Material List: From process information gathered from various sources, the following raw material list is prepared. Each raw

Raw Material	Case	USG	UNP	CAP	Code
Containers	1-4, 7-10	100	\$0.015		1
Compound Z	1	79.8	\$3.00	\$2.00	2
(60% yield on	. 2	79.8	2.75	1.75	3
	3	79.8	2.50	1.00	4
	4	79.8	2.00	0.75	5
	5	79.8	1.00	0.50*	6
	6	79.8	0.50	0.25*	7
Compound Z	7	62.9	3.00	2.00	8
(80% yield on	. 8	62.9	2.75	1.75	9
	9	62.9	2.50	1.00	10
	10	62.9	2.00	0.75	11
	11	62.9	1.00	0.50*	12
	12	62.9	0.50	0.25*	13
Sulfuryl chloride,	1	156.2	0.14		14
50% excess	2-6	156.2	0.13		15
over theory	7	123.0	0.14		16
	8-12	123.0	0.13		17
Aqueous caustic	1	150	0.035		18
soda, as 100% lye		115	0.035		19
	4	106	0.035		20
	7	118	0.035	****	21
	8-9	91	0.035		22
	10	84	0.035		23
Hydrated lime	5-6	106	0.01		24
	11-12	80	0.01		25
Chlorine,	1-4	100	0.05	0.100	26
(UNP and	5-6	100	0.05	0.095*	27
CAP are	7~10	79	0.05	0.100	28
fictitious)	11-12	79	0.05	0.095*	29
Activated carbon,	1, 7	. 8	0.16		30
2-mosh	2, 8	6	0.16		31
	3, 9	5	0.16		32
	4, 10	4	0.16		33
	5-6, 11-12	3	0.16		34
Activated carbon,	1,7	16	0.20	* * * *	35
4-mesh	2, 8	12	0.20		36
	3, 9	10	0.20	****	37
	4, 10	8	0.20		38
	5-6, 11-12	6	0.20		39
	7 (50% loss)	10	0.142		40
	8 (10% loss)	2	0.142		41
	9 (2.5% loss)	0.5	0.142		42
4,	10 (1% loss)	0.2	0.142		43

Estimation of Conversion Cost

Cases	Item	Lb./Cwt. Product	Lb./Gal.	Gal./Cwt. Product
1-6	Compound Z	79.8	8†	10.0
	Recycled product	7.9	10†	0.8
	Carbon tetrachloride	18.5	13.3	1.4
	Sulfuryl chloride	156.3	13.9	11.2
	Less SO ₂ evolved	55.5	11.9	-4.7
				18.7
7-12	Compound Z	62.9	8†	7.9
	Recycled product	6.2	10†	0.6
	Carbon tetrachloride	14.6	13.3	1.1
	Sulfuryl chloride	123.0	13.9	8.9
	Less SO ₂ evolved	43.7	,11.9†	-3.7
				14.8

[†] Estimated; volumes assumed to be additive.

Estimating PCB and CONCB

PCB is productive capacity and CONCB is total conversion cost for

IIIG DOS	e cuse.		
Cases	PR	PCB	CONCB
1-6	82,600 lb./mo.	992,000 lb./yr.	\$21.20/cwt.
7-12	104.300	1.250,000	16.80

Estimating Mechanical Alteration Costs (MECHT)

Cases 1,7	2, 8	3, 4, 9, 10
MECHT. \$ 8,000	10.000	12.000

Estimating Fixed Capital (MIFC)

The dollar values of the major equipment items (MIFC) are shown

Cases	1,7	2-4, 8-10	5, 6, 11, 12
MIFC, \$	93,000	102,000	108,700

Estimating Inventories

For estimation of inventories for the spot runs Eq. (16) will be used, and an inventory component is included in the backup factors used for Compound Z in these cases. An inventory factor of 1.00 is used, since chlorinated Compound Z is a finished product and a factor of

1.00 seems to describe the actual situation in these cases.
In cases 5-6 and 11-12 inventories are estimated as a percentage of sales, and no inventory component is included in the back-up factors for intermediates in those cases. (The computer program uses Eq. (15) and Eq. (16) to calculate inventories in this fashion.)

Computer Calculations

The quantities below are in every instance calculated by the computer routine. Equations used are as follows

-Eq. (17) Selling prices

Selling prices
Working capital
Total fixed plus working capital—Eq. (21)
—Eq. (23) Eqs. (18), (19) and (20)

Earnings Inventories -Eq. (15) and (16).

Fixed capital requirements for larger annual volumes in new plants are arrived at by extrapolation of data calculated for the basic case, using the correlation proposed by Sherwood, Chilton, and others. If the basic case is established for interim manufacture, equipment costs are up-dated for extrapolation by use of an appropriate cost index number.

The calculations are:

$$FC = FCBU + FCFP \tag{9}$$

$$FCFP = FCFPN + FCFPE \tag{10}$$

$$FCFPE = Input$$

$$FCFPE = MIFC \times LF \times EIN \times EF \times (S/PCB)^{C}$$
 (where $C = 1$) (11)

$$FCFPN = Input$$

$$FCFPN = Input + MIFC \times LF \times EIN \times EF \times (S/PCB)^{C+}$$

$$FCFPN = MIFC \times LF \times EIN \times EF \times (S/PCB)^{c} +$$
(13)

+ where
$$1 > C > 0$$

(12)

^{*} Inventory component not included.
† Assumed that CCI4 not to be used in large scale operation.

$$FCBU = \frac{S}{100} \left(USG_A \times CAP_A + USG_B \times CAP_B \dots \right)$$
 (14)

Estimate Inventories by Two Methods

Inventories may be estimated by two different methods, or an input value may be inserted.

For a product which clearly falls within an existing product group, the average inventory may be estimated as a percentage of annual dollar sales (in those cases in which the anticipated production rates and sales rates will be equal). Inventory experience factors for the product groups in the Organic Chemicals Division have been compiled and are revised annually.

For a new product which does not appear to fit into existing product groups, the inventories can be estimated (for those cases in which the production and sales rates will be equal) as being roughly equal to the dollar value of one month's usage of raw materials (valued at the purchase price) plus one month's output of finished product (valued at its manufacturing cost).

An "inventory factor" in the appropriate equation permits varying of the figure above and below the one month level if this should be deemed desirable.

The all-purpose inventory equation will also estimate inventories for the special situations encountered in interim or intermittent manufacture where the production rate is greater than the sales rate. This type of production pattern can result in high inventories.

$$INWC = Input$$

 $INWC = (S \times SP \times INWCP)/100$ (15)

$$INWC = (S/2) \times (1 - S/12PR) \times MC + S/12PR \times (MC + RMC/100) \times IF \times S/12$$
 (16)

Selling Prices: Key to Calculations

Selling prices over the range of 0-100% return before taxes on total fixed and working capital are calculated using the equation below:

$$SP = \frac{(100-IT)\times MC + RETP \times CIOS}{(100-IT)\times (1-0.01\times SAREP) - 0.01\times RETP \times Q} \quad (17)$$

Total working capital is the sum of inventories plus other items which are usually estimated as percentages of annual dollar sales. These other items are referred to variously as "cash," "all other" working capital, etc.

$$WC = INWC + SAREWC + A OWC$$
 (18)

$$SAREWC = SP \times S \times SAREWCP \times 0.01$$

$$A\, \theta WC = SP \times S \times A\, \theta WCP \times 0.01 \tag{20}$$

$$INWC = (Eq. 15) \text{ or } Eq. (16)$$

A different value will prevail for the above at each level of return on TFWC, since SP varies with return.

Then calculation of total fixed plus working capital would be:

$$TFWC = FC + WC \tag{21}$$

Annual earnings are calculated as:

$$E = TFWC \times RETP \times 0.01^* \tag{22}$$

$$E = S \times (SP - MC - SAREE) (100 - IT) \times 0.01^* \quad (20)$$

Computer Gives Production Rates

The computer will calculate production rates for the various cases and include this item along with a statement of the sales volume assumed in each case. These output data will appear on the report which summarizes the fixed capital requirements for each case,

$$PR = Input$$

$$PR = S/12 \tag{24}$$

$$PR = PCB/(12 \times EF) \tag{25}$$

Input and Output Data

We have developed a set of input data sheets for our computer calculations. † The computer output data obtained from this input will include selling price, earnings, AOWC, SAREWC, INWC, WC, FC and TFWC at various returns on investment.

Names for the distribution page, identified on the data sheet by a code number, are read from a master name file stored on tape.

The raw materials data sheet is used for a listing of all the raw materials used in a given problem. Each raw material is given a number, and the data for each numbered raw material are punched on a separate card. In computer calculation the raw material cards are fed into the machine, in order, after the title page cards (optional).

Data on these raw materials cards are transferred to magnetic tape. Thereafter, in making calculations for the individual cases, the computer searches this "raw materials" tape for data on the raw materials.

Other cards supply the remaining numerical data required for the computer program. Two to four cards (depending upon the number of raw materials used in the individual case within a problem) may be required per case. The number of cards in each case within a problem does not have to be the same.

In machine execution of the program the title page card and the raw material cards are first read in by the card reader. The remaining cards are then read in case by case, complete calculations for one case being completed before cards for the next case are fed in.

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Within Organic Research R. E. Howard and R. O. Nellum-have contributed support and encouragement plus many applic-able suggestions. The use of computer calculations in evalua-tion work with Organic Research was first suggested by Dr. Howard, and the extensive use of a computer in this work has stemmed from this original idea.

^{*} Earnings will vary as the return on investment varies, since SP varies with return. Either Eq. (22) or (23) may be used to calculate earnings at a given level of return on investment—the values calculated should be the same. Eq. 23 is used for calculating earnings in the computer program.

t Actual details of computer programming are beyond the ope of this article.

ABOVE 2.500 F.

What Material to Use?

New developments in theory and application presage broader uses for superrefractories.

LUTHER D. LOCH, The Carborundum Co., Niagara Falls, N. Y.*

PROCESSING at high temperatures, that is above 2,500 F., has become more and more intriguing in the past few years. Now, conditions appear to be favorable for really substantial progress in this field

Although many factors favor this technological breakthrough, these two are outstanding:

· Faster accumulation of thermodynamic and kinetic data on high-temperature chemical species.

· Vigorous effort to apply fundamental concepts to the development of optimum properties in refractory construction materials.

Rapid progress in both these areas has received much of its stimulus from the atomic energy and the missile programs.

Since much has already been said and written about the great potentialities of high-temperature chemistry and the many refractory materials that are waiting to be tested as possible structural materials, this article will give only brief mention to specific high-temperature processes and will concentrate on the special superrefractories and what can be expected of them in the way of ultimate properties.

The New Processes

Metal Chlorides Corp. has developed a very intriguing process for reduction-chlorination of ores at 2,500-3,000 F.1 A graphite tube serves as a resistance element and furnace chamber. Coke breeze, chlorine and ore-examples are chromite, spodumene, zircon, rutile, boron oxide-pass through a fur-

nace at velocities of 5-150 ft./sec. Chlorine conversion reaches 90% and large quantities of metal chlorides are produced in a relatively small furnace.

Calcium carbide is produced, without using electric power, by the German oxythermal furnace process.2 Lime and excess coke are charged to a graphite-lined shaft furnace. Oxygen is used to burn part of the coke, supplying the highreaction temperature needed for reduction. It's questionable whether this process would be economically attractive in the U.S. at the present time, but it may suggest other interesting possibilities in view of today's decreasing cost of oxygen.

The long-known thermite type of reaction is being diversified and commercialized as a result of advances in technique, in refractories and in purity of starting materials.3 Metals other than classical aluminum are being used to reduce halides as well as the traditional oxides. Refractory crucibles used to contain the charge must withstand considerable thermal shock and should not react too severely with the metal and slag phases.

In the field of extractive metallurgy in particular, chemical-engineering operations are being applied at higher and higher temperatures. The purest zinc, sodium, magnesium and calcium are prepared by distillation. Molybdic oxide of 99.95% purity is being

made by sublimation at 1,500 F. With increasing knowledge of high-temperature chemistry and materials many of the standard chemical-engineering operations such as distillation, extraction,

crystallization and sublimation may become widely applicable to hightemperature systems.

Special Superrefractories

For this review, materials of prime importance have single-phase microstructures without the clay or siliceous bond usually found in the more common refractories. Leaving out this bond adds immeasurably to the high-temperature resistance of the product.

Instead of a highly refractory "grog" being held together by a less-refractory matrix, the "grog" is bonded to itself. A refractory of this type—if made from pure materials—will not undergo internal melting or other structural changes to nearly the same extent as less-pure ceramically bonded refractories.

Achievement of enhanced properties by leaving out the ceramic bond requires the use of unconventional forming methods. Special superrefractories are prepared by sintering, fusion casting, hot pressing or by promoting a bond chemically in situ, after pressing to shape.

All of the materials that we will describe here have the inherent properties of a good refractory: high melting point, low volatility, good hot strength. Finding a refractory that will withstand a specified temperature for a particular job requires an understanding of the subsidiary properties that each material offers.

In the absence of reliable tests in

simulated or actual service, the best approach to selection of materials is one based on the type of chemical bond. This approach gives us these four classes for superrefractories:

• Ionic substances, chiefly the

 Covalent carbides and nitrides.

• Metallic carbides and ni-

 Mixed covalent-metallic substances, chiefly dioborides and disilicides.

Oxides: Large Tonnage Stuff

Pure oxides are the end-members of the multicomponent systems from which most of our large tonnage refractories are derived. To qualify as a pure oxide, a material must contain less than 0.5% of impurities. And even this amount of impurity may cause a significant loss of refractoriness and load-bearing ability in certain cases.

Except for beryllia, which may have as much as 50% covalent character, chemical bonding in the refractory oxides is predominantly ionic. High ionic mobility results in a gradual development of plasticity up to the melting point, which is very sharp and is observed at ordinary pressures.

An excellent discussion and tabulation of the physical, chemical and mechanical properties of oxide refractories has recently appeared in this publication (*Chem. Eng.*, April 21, 1958, p. 135). However, there are two "sleepers" among the ox-

ides that have not been mentioned previously because there are serious drawbacks to their use.

Calcium oxide is abundant and very refractory but is not used because it hydrates readily at normal temperatures and humidities. A real breakthrough would be required to make calcia a useful refractory.

Hafnia has been said to be a more promising refractory than zirconia, except for its high cost. In hafnia, the monoclinic-to-tetragonal inversion occurs at 3,100 F. with a volume expansion of 3.4%, compared to 2,000 F. and an expansion of 7.5% in zirconia. It seems, therefore, that hafnia would present less of a problem than zirconia with respect to physical stability at high temperatures.

Possibly hafnia might be used without stabilization, in which case volatilization of the stabilizing agent would not be a problem (as it sometimes is with zirconia). Separation of hafnia and zirconia is an expensive process, indeed. However, hafnia powder is now available commercially and further research by physical ceramists may result in its acceptance as a useful special refractory.

Covalent Carbides, Nitrides

Of the many covalent carbides and nitrides only SiC, BN and Si_s N_s are being produced commercially. The rest either hydrolyze too readily, are too volatile or have not been sufficiently developed.

Selected Properties of a Self-Bonded, Recrystallized Silicon Carbide—Table I

Oxidation resistance in air at 2,190 F., weight gain in milligrams/sq. cm.

Thermal conductivity per inch of thickness, Btu./hr.-sq. ft.-deg. F.

Mean linear thermal coefficient of expansion, 10-6 per deg. F.

Bending strength, 103 psi.

Young's modulus, 106 psi.

4	5 hr.	0.51
•	20 hr.	0.55
7	60 hr.	0.52
4	750 F.	500
	1,110 F.	400
	1,470 F.	333
7	1,830 F.	290
4	80- 570 F.	2.05
	80-1,290 F.	2.18
	80-1,830 F.	2.23
7	80 –2,190 F.	2.17
À	80 F.	24
9	2,190 F.	25
٦	2,730 F.	18
À	80 F.	68.5
	2,190 F.	61.5
٧	2,730 F.	49.4
4		



Boron Nitride and . . . Graphite—Table II Comparing the Properties of . . . (Hot Pressed) (Extruded) Density, grams/cc. 2 256 9 95 True or X-ray >2.101.55 - 1.65Bulk density of shapes 5,400 6.500 Sublimation temperature. F. Resistance to oxidation Good to 1,800 F. Good to 800 F. Parallel To Perpendicular Perpendicular To Parallel To Extrusion Axis To Avis Axis Pressing Axis 570 F..... 872 105 199 582 Thermal conductivity per inch of 348 524 1,300 F..... 92 187 thickness, Btu./hr.-sq. ft.-deg. F. 262 486 1,800 F..... 86 185 75- 660 F... 5.64 0.33 3 50 1 60 Mean linear coefficient of thermal 75-1,300 F... 4.48 0.49 3.78 2.11 expansion, 10⁻⁶ per deg. F. 75-1,800 F... 2.50 4.17 0.43 4.17 75 F..... 7 98 4.0 15.88 570 F..... 15.14 7.03 Bending strength, 103 psi. .300 F..... 3.84 1.90 1,800 F..... 2.18 1.08

Boron carbide (which on the basis of crystal structure might be more logically classed as a boride) has never been a significant factor in the refractories field because it is expensive and lacks any outstanding properties as a refractory.

Although silicon carbide now, is a very familiar refractory, a new self-bonded form of recrystallized silicon carbide (designated as KT by the Carborundum Co.) has such exceptional characteristics that it merits inclusion here. Because of its dense structure, it is impermeable and far superior in chemical resistance and mechanical properties to any previous silicon carbide product. For example, its true or X-ray density is 3.22 grams/cc.; and the actual density of shapes is more than 3.10 grams/cc. Decomposition temperature is 4,500 F. Other selected properties are given in Table I.

At 1,800 F. the thermal conductivity of KT silicon carbide is twice that of beryllia. It resists the chemical attack of such diverse materials as aluminum, cryolite, salt melts, indium and pure sodium.

The common crystal form of boron nitride has a structure very similar to that of graphite. Because of this similarity and the fact that graphite is a very useful special refractory, it's interesting to compare their properties. We've done this in Table II.

Both materials have layer-lattices and show preferred crystal orientation which results in directional variation of many of their properties. Both materials are readily machinable and have considerable lubricity.

Although boron nitride probably is more widely known for its mechanical and electrical properties, it has some outstanding chemical properties that are drawing considerable attention. The hot-pressed material resists molten iron, silicon, aluminum, cryolite, copper and zinc. It resists chlorine up to 1,300 F. It shows noticeable hydrolysis in hot aqueous solutions.

Silicon nitride, Si_a N_i, is another promising contender among the covalent compounds. Its sublimation temperature of 3,450 F. is somewhat lower than that of some of the other covalent refractories but is sufficiently high for many-foreseeable uses. Silicon nitride

shows low rates of oxidation in air up to 2,190 F. and is nearly comparable in thermal-shock resistance to materials such as silicon carbide. Like other covalent materials, its strength decreases very little with increasing temperature.

Silicon nitride shapes are prepared by nitriding preforms of silicon at about 2,370 F. The silicon is shaped by pressing, extrusion or slip casting with the latter method apparently favored for most current production.

Silicon nitride resists a number of aqueous and fused-salt corrodents.⁵ It has excellent resistance to some nonferrous metals, as shown in Table III. Here are some of its physical properties: true density, 3.44 grams/cc.; bulk density, 3.08 grams/cc.; modulus of rupture at room temperature, 10,000 psi.; compressive strength at room temperature, 72,000 to 90,000 psi.; thermal conductivity per inch

Resistance of Si₃ N₄ to Molten Metals-Table III

	Temperature, Deg. F.	Holding Time, Hr.	Degree Of Attack (Ref. 5)
Aluminum	1,470	950	None
Aluminum	1,830	100	None
Lead	750	144	None
Tin	570	144	None
Zinc	1,020	500	None
Magnesium	1,380	20	Slight
Copper		7	Severe

of thickness (between 400 and 2,400 F.), 10.83 Btu./hr.-sq. ft.-deg. F.; and linear expansion coefficient (between 68 and 1,830 F.), 2.4×10^{-6} per deg. F.

Uses for silicon nitride include thermocouple protection tubes in aluminum casting operations and in thermocouple assemblies for checking temperatures of combustion gases in open-hearth furnaces.

Most promising application for silicon nitride is in processing germanium for transistors.

Metallic carbides and nitrides have crystal structures closely related to those of the parent metals. The relatively small carbon or nitrogen atoms fit into the interstices between the larger (usually close-packed) metal atoms. Therefore, these compounds often are called interstitial compounds. They have the low electrical resistivity of the metals but are much harder and more refractory than most metals.

Several of the refractory carbides and nitrides are made commercially, chiefly those of tungsten, molybdenum, titanium and zirconium. However, they have poor oxidation resistance, and poor resistance to halogen gases and a number of other common corrosive materials. Their use as materials of construction in the chemical process industries is very limited today and is likely to remain so in the future.

Diborides and Disilicides

Diborides and disilicides have a combination of metallic-covalent bonding and exhibit thermal and electrical conductivities approaching those of metals. In consequence of their covalency, however, they do not exhibit plastic flow except at rather high temperatures.

Considerable research has been devoted to the diborides of Ti, Zr, Cr and Mo but much of it apparently with relatively impure materials. It is known that TiB, and ZrB, have much better oxidation resistance than the carbides or nitrides of the same metals. The diborides show little tendency to react with carbon or nitrogen. They are resistant to HCl and HF but are attacked by hot H,SO,, strong oxidizing agents and basic melts.

Although few data on the chemical properties of hafnium diboride have been reported, it presumably would behave similarly. Diborides of Groups V and VI do not have outstanding oxidation resistance and very little has been reported concerning their general chemical resistance.

We have shown the physical properties of three Group IV diborides in Table IV. The thermal-shock resistances of the diborides have not been evaluated, but their relatively high thermal conductivities and low expansions should result in good resistance.

In fact, ZrB₂ rocket nozzles on occasion have shown exceptional shock resistance. Apparently not enough is known about the composition and fabrication variables to obtain dependable results. However, because of their great heat resistance, the diborides may be very useful in applications requiring good thermal and electrical conductors that withstand high vacuum or reducing conditions at high temperatures.

Diborides are not widely used as commercial refractories now and are currently formed to shape by costly hot-pressing techniques. Still, there is no fundamental reason why cheaper fabrication processes can't be developed.

What about their possible use in high-temperature chemical processes? Well, the diborides appear to have a much greater potential than the interstitial carbides and nitrides. If a demand materializes, cheaper fabrication processes and

better control of their properties certainly will be developed.

The disilicides of Mo, Ta and W are sufficiently refractory to be of some interest for high-temperature chemical processing. Their melting points are 3,400, 4,350 and 3,700 F., respectively. As a class, they seem to have somewhat better oxidation resistance than the diborides. However, carbon is readily taken into solution at high temperatures. This deteriorates the oxidation resistance.

MoSi₂ has received more attention than the other disilicides. Persistent research and development efforts have largely overcome its initially pronounced lack of creep resistance and have improved its oxidation resistance considerably. Heating elements have been developed to operate at 3,100 F. for hundreds of hours without failure. But note that MoSi₂ is not resistant to thermal shock and this is a serious deficiency in many applications.⁷

Most inorganic acids do not attack MoSi₂; but it is rapidly attacked by concentrated HF-HNO₃ mixtures. It is resistant to aqueous alkalies, but easily soluble in molten alkalies. It is attacked by fluorine at room temperature and by chlorine at elevated temperatures. See Table V for some of its mechanical properties.

Although the disilicides might be used in some very specialized chemical applications, their mechanical deficiencies and lack of

Some Properties of Refractory Diborides—Table IV

	Melting Point, F.	Density Grams/cc.	Thermal Cond. Per Inch, Btu./Hr Sq. FtDeg. F.	Linear Thermal, Expansion 10 ⁻⁶ /Deg. F.	Bending Strength, Psi.
TiB_2,\ldots	ca. 4,700	4.5	175		19
ZrB ₂	5,400	6.1	175	3.06	29
HfB.	5 500	10.5		3.06	

Mechanical Properties of MoSi₂—Table V

Short-time tensile strength		At 1,800 F.	40,000 psi.
of hot-pressed forms:	-	2,000 F.	42,200
		2,200 F.	42,800
		2 400 F	41 100

Creep-rupture of hot-pressed, coarse-grained forms:

Temperature,	Stress,	Rupture	Creep Rate,
Deg. F.	Psi.	Time, Hr.	In./InHr.
1,800	20,000	224	$2.8 imes 10^{-5}$
1,900	12,000	110	$7.3 imes10^{-4}$
2.000	10.000	85	1.8×10^{-3}

outstanding corrosion resistance do not suggest widespread applicability in the future.

Metal-Ceramic Combinations

Research on cermets was begun with the intention of combining the ductility and thermal-shock resistance of the metals with the heat resistance of ceramics. Several years of research have resulted in far less success than originally hoped

Metal content gradually has been increased from the 15 to 20% used in the earliest compositions to 80% or more. During this long evolution, the refractory properties have been largely sacrificed for the sake of toughness and ductility. The expected blend of the best qualities of metals with those of nonmetals has not materialized.

Considerable progress has been made on metal-bonded carbide compositions that have promising properties for jet-engine and gas-turbine applications. But these are not likely to become very important in high-temperature chemical processes because of poor general corrosion resistance.

A family of oxide cermets called the LT series has some intriguing properties. Consisting of alumina bonded with Cr. Cr-Mo, or Cr-W, the LT cermets have very good oxidation resistance to 2,300 F. and above, excellent corrosion resistance and adequate strength. They are relatively brittle and not recommended for use under high stress or mechanical-shock conditions. They should not be used in carburizing atmospheres or in contact with molten aluminum, acid slags or carbide slags.

Perhaps a more fruitful approach to metal-ceramic combinations than the traditional cermets is that represented by SAP (sintered aluminum powder). In this structure the metal is the discontinuous phase. Fine particles of aluminum are bonded together by a thin coating of aluminum oxide on the metal surfaces. They are compacted into a dense shape. Resulting shapes resist temperatures at least 200-deg.-F. higher than conventional aluminum products can withstand.

Research directed towards applying this principle to the more refractory metals undoubtedly will be undertaken in the near future.

For Nuclear Reactors

About three years ago, gas-cooled nuclear reactors received a second look in this country and were found to be in the picture for remote military power, for some types of propulsion, and possibly even for central station power applications.

This renewed interest has been accompanied by a greater emphasis on refractory materials with good nuclear properties. Uranium dioxide already is being used in large power reactors of the pressurizedwater type. However, it is in gascooled reactors that the refractory nonmetallics offer great improvements in efficiency and economy of space.

Actually the current large-scale use of UO2 as a reactor fuel is based on its corrosion resistance in highpressure water, not on its properties as a refractory. In spite of its high melting point, 4,950 F., it has little to recommend it as a massive fuel for applications involving high heat fluxes. In addition to its low thermal conductivity and poor thermal-shock resistance, UO has poor resistance to oxidation.

Thus, other refractory uranium compounds such as carbides, nitrides and possibly the diborides will be considered as fuels for gascooled reactors.

Nonfuel refractories may be called upon to serve as "matrices" in composite fuel elements. matrix would hold the fuel in place, prevent the fission products from entering the coolant stream and possibly protect the fuel from reacting with the cooling gas. In cases requiring the maximum utilization of neutrons, dense beryllia appears to be the only possibility.

In addition to the fuels and fuelmatrix materials, ingredients for control rods will be required. Among the high-melting substances with the necessary high-neutroncapture cross sections are the borides, hafnium oxide, hafnium carbide and the rare earth oxides, Sm₂ O₃ and Gd₂O₃. All of these materials are being studied with a view to satisfying the requirements of the future.

What About the Future?

To those with sufficient daring and vision, high-temperature processing offers challenging opportunities for important breakthroughs

in the availability and cost of many chemical products, old and new. Some products such as ozone, gallium and other less-familiar metals will find broad application only if they can be sold at much less than today's prices.

Cost of high-temperature energy, from whatever source, will always be a major consideration. However, the economics of energy production and distribution are always changing. High-temperature processes that were discarded a few years ago because of energy cost may become profitable tomorrow.

For example, the decreasing cost of tonnage oxygen should make it more economical to attain high temperatures by combustion.

So far as construction materials are concerned, the known refractory substances should be sufficient to satisfy most foreseeable combinations of service requirements if each material is developed to the optimum. Accomplishing this represents a great challenge to the solid-state physicist and the physical ceramist.

Research being done at the Univ. of Calif. on ductile ionic ceramics offers some hope that nonmetallics need not always be as subject to mechanical failure as they are now.

It's unlikely that any new binary compounds with extreme refractoriness will be synthesized from known chemical elements. On the other hand, there are indications that fundamental studies on certain ternary systems would be fruitful.

Some special refractories are now too expensive to consider for many applications. However, except in cases where existing deposits of the necessary ores are truly limited, we can expect that costs will be brought to reasonable levels as demand develops. It is up to both the chemical industry and the refractories industry to see that the opportunities in high-temperature processing are translated from the "blue-sky" category into accomplished fact.

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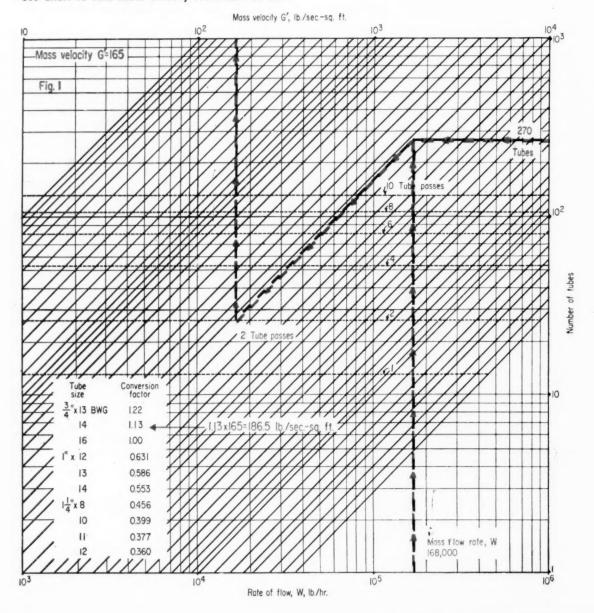
New, Fast, Accurate Method to Find

NING HSING CHEN

Heat Transfer Div., M. W. Kellogg, Jersey City, N. J. Meet your author on p. 140.

In Heat exchanger design, it's possible to use an equation for calculating heat transfer coefficients for petroleum fractions flowing inside the tube. Several charts and a nomograph have been published

Use Chart to Find Mass Velocity From Rate of Flow



Tubeside Heat Transfer Coefficient

to speed up calculations of this Sieder-Tate equation. However, those charts need appreciable time and the nomograph may be in error by as much as 20%.

In this article, the method detailed gives heat transfer coefficients within 5% of the values obtained from the Sieder and Tate equation. Further, these new charts give the result rapidly and without extensive mathematics.

To illustrate the use of the charts, let us solve a typical problem.

Problem—Find the heat transfer coefficient on the tube side for a fluid into a 1-2 exchanger at a mass rate of 168,000 lb./hr. The fluid is heated inside 270 tubes (¾ in. × 14 BWG) in two passes from 90 to 150 F.

At the average temperature of 120 F., the fluid has the following properties: viscosity, Z=0.85 centipoise; thermal conductivity, k=0.098 Btu./hr.-sq. ft.-deg. F.-ft. and specific heat, C=0.51 Btu./lb.-hr.-deg. F.

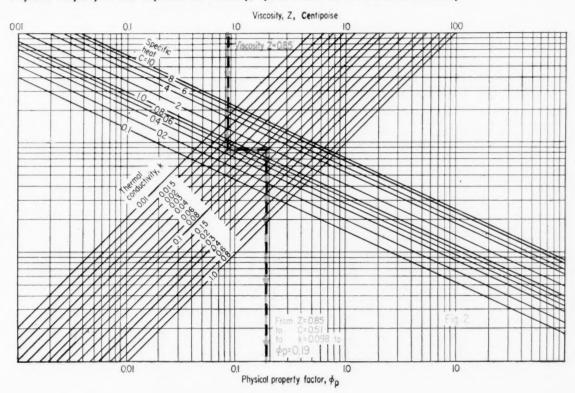
We use the accompanying charts to solve the problem graphically in three steps.

Step 1—Find the mass velocity G', lb./sec.-sq. ft. Using Fig. 1, erect a line vertically through mass flow W=168,000 to meet the line drawn horizontally from number of tubes which is 270. Through this intersection, draw a line at 45° to meet at the number of tube passes line of 2. From this intersection, draw a line vertically, to the mass velocity line G'. Read the mass velocity G' which is 165 lb./sec.-sq. ft. Multiply 165 by 1.13 which is the conversion factor for the correct tube size to get G'=186.5 lb./sec.-sq. ft.

Step 2—Find the physical property factor ϕ_p from Fig. 2. Erect a line through viscosity Z=0.85 to meet line of specific heat C=0.51. From this point draw a line horizontally to meet line of thermal conductivity k=0.098. The abscissa of this intersection gives the physical property factor $\phi_p=0.19$.

Step 3—Find the heat transfer coefficient from Fig. 3. Using mass velocity found in Step 1, draw a line at G'=186.5 to intersect on the physical property line where $\phi_p=0.19$. The ordinate of this point is the heat transfer coefficient corrected for viscosity. Multiply

Physical Property Factor Depends on Viscosity, Specific Heat and Thermal Conductivity



270 by the conversion factor of 1.011 for the correct tube size gives heat transfer coefficient equal to 274 Btu./hr.-sq. ft.-deg. F.

How the Charts Were Made

In heat exchanger design, we use the Sieder and Tate equation for flow inside the tubes. For turbulent flow where Reynolds number is 10,000 or larger (D'G'/Z = 80 or more), the equation is

$$hD/k = 0.027 (DG/\mu)^{0.8} (C\mu/k)^{1/3} (\mu/\mu_{\omega})^{0.14}$$
 (1)

Nomenclature-

- C Specific heat, Btu./lb.-deg. F.
- Inside tube diameter, ft. D
- D'Inside tube diameter, in.
- Mass velocity inside tube, lb./hr.-sq. ft. G
- Mass velocity inside tube, lb./sec.-sq. ft. G'
- Heat transfer coefficient (based on internal surface), h
- Btu./hr.-sq. ft.-deg. F. Thermal conductivity, Btu./hr.-sq. ft.-deg. F.-ft. L
- N_T Number of tubes, dimensionless.
- Number of tube passes, dimensionless.
- W Mass rate of flow, lb./hr.
- Viscosity at average fluid temperature, centipoise. \mathbf{z}
- Z ... Viscosity at tube wall temperature, centipoise.
- Viscosity at average fluid temperature, lb./hr.-ft.
- pt.
- Viscosity at tube wall temperature, lb./hr.-ft. 11.00 Physical property factor, $(C^{0.53} k^{0.66}/Z^{0.47})$. do
- Viscosity correction factor, $(Z/Z_w)^{-0.14}$. di.

In engineering units, Eq. (1) becomes

$$hD'/k = 20.6 (D'G'/Z)^{0.8} (CZ/k)^{1/3} (C/Z_w)^{0.14}$$
 (2)

We can further simplify Eq. (2) to give:

$$(Z/Z_w)^{-0.14} h = 20.6 [(G')^{0.8}/(D')^{0.2}] (C^{0.33}k^{0.66}/Z^{0.47})$$
 (3)

The term $(C^{0.38} k^{0.66}/Z^{0.47})$ depends on the physical properties of the fluid and may be called the physical property factor ϕ_p . We can now represent Eq. (3) as:

$$\phi_s h = 20.6 \left[(G')^{0.8} / (D')^{0.2} \right] \phi_p$$
 (4)

where $\phi_{\epsilon} = (Z/Z_{\rm w})^{-0.14}$. We use Eq. (4) to make Figs. 2 and 3.

We represent the correlation of G' and the number of tube passes P, the number of tubes N_T and the mass rate of flow W by

$$G' = WP/19.6(D')^2 N_T$$
 (5)

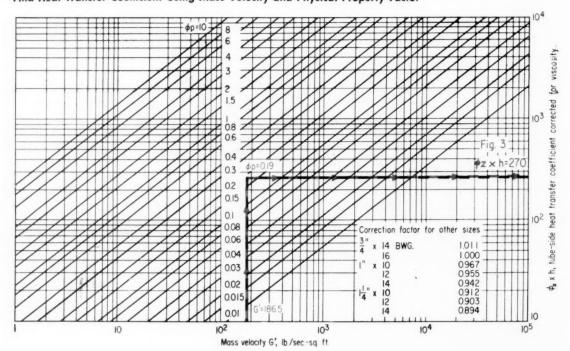
From Eq. (5), we construct Fig. 1.

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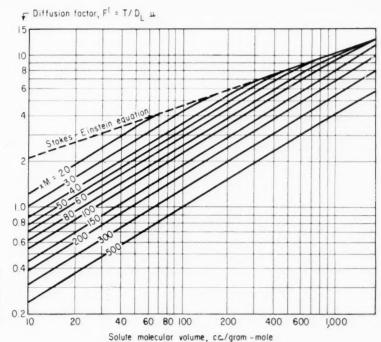
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Find Heat Transfer Coefficient Using Mass Velocity and Physical Property Factor



Answer: Heat transfer coefficient corrected for viscosity and tube size=270x10II=274 Btu/hr-sq ft-deg F.



Although restricted to dilute nonelectrolytes, this chart by Wilke and Chang is one of several approaches you can use to . . .

Predict Liquid Diffusivities

With mighty few data available in the literature, these prediction and extrapolation methods will prove to be best.

WALLACE R. GAMBILL, Union Carbide Chemicals Co., Charleston, W. Va.*

DIFFUSION in the liquid state is qualitatively the same as in the gaseous state (for gas methods, see Chem. Eng., June 2, 1958, p. 125).

But successful theoretical prediction equations for diffusivity have not been developed because of the generally unsatisfactory descriptions of the liquid state presently available. However, a number of empirical and semi-empirical methods have been proposed and these will be discussed here.

the literature have been calculated

Most Use This Form Most liquid-phase diffusivities in

from experimental data by the following simple form, which then defines D_{i} :

$$N_1 = D_L \left(\Delta C_1\right)/z \tag{1}$$

which is obtained from,

$$N_1 = -D_L \left(\frac{dC_1}{dz} \right) \tag{2}$$

for steady-state diffusion of a solute through a solvent.

For liquid, dissolved-solid and gaseous solutes in dilute liquid solutions around room temperature, the full range of D_L is about 0.2×10^{-5} to 5.2×10^{-8} cm.²/sec., with 1.0×10^{-5} cm.²/sec. (which is also about 1 cm.2/day) perhaps a representative average. For the common gases in dilute aqueous solution at room temperature, 1.8 × 10⁻⁵ is a good average figure.

It's interesting that though D_v is

about 10° to 10° the value of D_{i} , molecular-diffusive transport in gases is only 10 to 100 times more "efficient" than in liquids. This is so because the diffusion for a given concentration difference across a unit distance is proportional to ρD , and ρ_L is approximately 1,000 ρ_V .

Vol. 5 of the "International Critical Tables" is probably the best data source for D_L values.

Methods for Nonelectrolytes

Considering specific estimation methods, we'll divide our subject matter into: dilute solutions of nonelectrolytes; effect of temperature; concentrated solutions of nonelectrolytes; and the diffusivity of electrolytes.

^{*}Mr. Gambill is now with the Union Carbide Nuclear Co., Oak Ridge, Tenn. To meet your author see Chem. Eng., Feb. 10, 1958, p. 173.

The next six methods are for dilute solutions of nonelectrolytes.

Method 1-Stokes-Einstein

We treat this relation first because of its historical importance and because the best generalized estimation method (to follow below) is based on it.

The equation, derived for dilute solutions only, is:

$$D = kT/6\pi r \mu \tag{3}$$

If the molecule is assumed spherical, then:

$$r = (3V/4\pi N)^{0.33} \tag{4}$$

and.

$$D_L = T/(1.004 \times 10^7) \,\mu V^{0.33} \, (5)$$

Eq. (5) applies only when the diffusing molecule is so large compared to the molecules of the solvent in which it is diffusing that the solvent may be considered a

Nomenclature_

- A A constant; or "abnormality" factor.
- b, BConstants.
- Sutherland constant (gas), deg. K; or molar liquid-phase concentration.
- Differential operator.
- Diffusion coefficient, cm.3/sec. D 2.713
- The group $(T/D_{L}\mu)$ for liquidphase diffusion.
- Boltzmann's constant, ergs/deg.
- M Molecular weight.
- Molar rate of diffusion, grammoles-sec./cm.2; or Avogadro's number.
- Total pressure, atm. abs.
- Radius of solute molecule.
- Temperature, deg. C.
- T Absolute temperature, deg. K.
- Valence of cation.
- Ionic velocity of cation at infinite dilution, cm./sec.-dyne.
- Valence of anion.
- Ionic velocity of anion at infinite dilution, cm./sec.-dyne; or molecular liquid volume at Tb, cc./ gram-mole.
- Path length for diffusion, cm. 2
- Liquid viscosity, centipoises.
- Density, grams/cc.
- Surface tension. σ

Subscripts

- At the normal boiling point. h
- At the critical point.
- For liquid.
- For vapor or gas.
- 1 & 2 For gases, denotes components 1 and 2, respectively; for liquids denotes solute (diffusing) and solvent, respectively.
- 1.1 Denotes self-diffusion.
- 1, 2 For a binary system.

continuum. The relation is quite valid, then, for cases such as diffusion of colloidal particles through liquids or for a high-molecular weight liquid in a low-molecular weight solvent (such as water).

Wilke's correlation 11. 25 indicates that with water as solvent, the Stokes-Einstein equation falls off in accuracy for solute molar volumes less than about 400 cc./gram-

Method 2-Wilke and Chang

Wilke in 1949 proposed21 a generalized correlation for D_L that was based on the Eyring theory of absolute reaction rate and the Stokes-Einstein equation.

His correlation is a plot of F' = $T/D_1\mu$, dubbed the "diffusion factor," vs. solute molar volume at the normal boiling point. Since the group $(T/D_t\mu)$ is essentially independent of temperature for a given solute-solvent system, the influence of both solute and temperature are correlated. The influence of the solvent is roughly taken into account by an empirical "solvent factor," φ.

The result is a correlation with an over-all average error of 10.4% for 168 points representing a considerable variety of solutes in 17 solvents, primarily water, methanol and benzene.

Coulson and Richardson,28 Sherwood and Pigford23 and Scheibel24 all proposed simple empirical equations which represented Wilke's graphical correlation fairly well over the main regions of interest.

However, in 1955 Wilke and Chang25 extended their earlier correlation by including a large amount of diffusivity data which had become available since 1949, by developing a better empirical function to express the effect of solvent properties and by distinguishing between associated and unassociated solvents. Their first generalized relation became:

$$D_L = \frac{(7.4 \times 10^{-8}) (x M)^{0.5} T}{\mu V^{0.6}}$$
 (6)

where x is an "association parameter" used to define the effective molecular weight of the solvent with respect to the diffusion process. For nonassociated solvents (all except water, methanol and ethanol in the case of Wilke and Chang's study) x = 1; for water x= 2.6; for methanol x = 1.9; and for ethanol x = 1.5.

The chart on the previous page

is the generalized diffusion-factor chart of Wilke and Chang.88 For hydrogen-bonding solvents other than those mentioned here, the parameter x may best be evaluated by locating on the chart values of F' based on all available data. The V term of Eq. (6) should be calculated from additive values of atomic volumes at the normal boiling point by Kopp's rule (see Chem. Eng., June 2, 1958, p. 127).

This method applies specifically to dilute solutions (say 0.1 molar, or less) of nonelectrolytes. Total temperature range of all data is 0-50 C., the solvent viscosity range is tenfold, and the range of experimentally determined D_{ι} values is $0.149 \times 10^{-5} \text{ to } 4.75 \times 10^{-5} \text{ cm.}^2/$ sec. Approximate average deviations were:

· Over-all average for 285 points and 251 solute-solvent systems, 10%.

• For unassociated solvents only, 155 points and 123 systems,

• For water as solvent, 6%.; for methanol, 11%; for ethanol, 7%.

In the case of some solutes of high-molecular weight, which influence solvent viscosity appreciably even at low concentrations, use solution rather than solvent viscosity for µ.

Method 3-Arnold

A theoretical equation developed by extending a modified kinetic theory of gases to liquids was proposed by Arnold.26

This relation, which is limited to a temperature of 20 C., to very dilute solutions and to relatively low-boiling solvents, gives satisfactory results (most calculated values deviate by < 10-15%) but the amount of data required does not allow generalized application of the method.

Arnold's equation is similar to that of Gilliland's for gases:

$$D_L = \frac{0.0100[(M_1 + M_2)/M_1M_2]^{0.5}}{A_1A_2\mu_2^{0.5}(V_1^{0.23} + V_2^{0.23})^2}$$
(7)

where A_1 and A_2 are "abnormality factors" which correct for association and abnormal intermolecular attractions. Arnold26 has listed values of A2 for a number of solvents and of A1 (which is somewhat dependent on the value of A_s for the solvent) for several solutes. These specific and essentially empirical "A factors" destroy the generality of the method.

Method 4-Olson and Walton

In a novel approach to estimating D_L , Olson and Walton[#] related D_L for dilute aqueous solutions of organic liquids to the slopes of surface tension lowering-concentration curves at low concentrations. Their final correlation was a plot of either D_L or $(D_L \ \mu/T)$ vs. $(\Delta \sigma/C_1)$ with parametric lines of pure-solute surface tension.

For 11 organic compounds diffusing in water, the average deviation was only 2.64% (max. of 5.5%). A method was also proposed for estimating $(\Delta\sigma/C_1)$ in the absence of specific data.

The special data required by this method and lack of extensive testing with many types of compounds preclude its use for a generalized engineering estimate at this time. However, the method appears most promising and should be developed further.

Olson and Walton also pointed out a convenient rule that can be used if sufficient data are available: The ratio of the unknown diffusion coefficient of a given compound in a new solvent to a known coefficient for another compound in the same solvent can be approximately equated to the ratio of the known coefficients of the same compounds in water (or other solvent):

$$(D_1/D_2)_x = (D_1/D_2)_{water}$$

within about 10%.

Method 5-Othmer and Thakar

Othmer and Thakar²⁸ developed a modified type of reference-substance correlation for estimating D_L , ending up with equations, graphs and a nomograph for three cases: water as solvent at 20 C.; water as solvent at any temperature; and any solute-solvent at any temperature.

The generalized correlation does not appear in this instance to be as satisfactory as others that have been proposed for other properties by Othmer and coworkers. The equations limited to water as solvent are apparently as accurate as any available; but the Wilke-Chang general correlation is definitely superior when solvents other than water are considered.

Some Interesting Sidelights

There are some other miscellaneous methods—interesting sidelights—none recommended for use.

Ionic Velocities, U and V, for Use in Nernst's Equation*

Cation	$U \times 10^{17}$	$\alpha \times 10^4$	Cation	$U \times 10^{17}$	$\alpha \times 10^4$
Li+	35.8	265			4 /1 20
			13Cr+++	48.4	0.0
Na+		244	¹ ₂ Mg ⁺⁺	49.3	256
Ag+	58.0	229	1.2Zn++	50.5	254
K*	69.4	217	12Cu++	49.3	2.5.2
TI+	70.8	215	½Cd++	49.9	245
Rb ⁺	72.5	214	12Sr++	55.7	247
Cs ⁺	73.0	212	220a	55.7	247
H*	337	154	1/2Ba++	59.5	239
NH4*	69.5	222	1/2Pb++	65.3	240
1/2Be++	30.1		1/2Ra++	62.4	239
½Mn++	47.2		1/3Al+++	43.0	
1/2Co++	46.2		1,61,9+++	65.5	***
16 11	47.2		13La+++ 13Sm+++	57.5	
12Fe++	48.3		14Th++++	25.3	
1/3Fe+++	65.5		74111	20.0	
Anion	$V \times 10^{17}$	$\alpha \times 10^4$	Anion	$V \times 10^{17}$	$\alpha \times 10^4$
F	50.1	238	IO ₄	51.6	
CI	70.4	216	ClO ₄	68.8	
I	71.6	213	NO ₃	66.4	
Br	72.7	215	OH-	187	180
SCN-	60.9	221	OH ½C ₂ O ₄	67.6	231
10 -					
10_3	36.5	234	1/2SO ₄ —	73.5	227
$C_2H_3O_4$	37.6#	238	½CrO ₄	77.4#	
ClO ₃	59.2	215	½CO ₃	64.5 #	270
BrO_3^-	51.1		1/4Fe(CN)6	102	

Notes—#—Uncertain value. α is the temperature coefficient to be used in this equation:

$$U_{cc} = U_{tt} \left[\frac{2 + \alpha (t_2 - t_1)}{2 - \alpha (t_2 - t_1)} \right]$$

where t is in deg. C. Also, all values in this table are at infinite dilution and at 18 C. Units of U and V are cm./sec.-dyne. *From Ref. 35.

Theoret proposed an early empirical rule for D_L :

$$D_L \mu M^{0.5} = a constant$$
 (8)

where μ is the viscosity of the solvent and M is the molecular weight of the solute.

This rule, though quick, is also quite inaccurate.

For the special case of self-diffusion (a substance diffusing through itself), equations developed by Eyring and coworkers can be changed to the approximate form:

$$(D_L)_{1,1} = kT/2r \mu$$
 (9)

In this instance, solute and solvent molecules are identical.

In the Stokes-Einstein case, where solute or diffusing molecules are much larger than those of the solvent, the denominator of Eq. (9) is larger by 3 π . This factor of ($\frac{1}{2}\pi$) represents the extreme theoretical range of variation of D_L as brought about by differences of molecular size.

Burnside¹⁹ interestingly noted that Gilliland's prediction equation for D_r will give values of D_L within a factor or ± 2 if internal pressure P_t of the liquid phase is used for P; $P_t = \Delta E_r/V_L$, where V_L is molar liquid volume and ΔE_r is internal heat of vaporization.

Herzog³¹ proposed that:

$$D_L = \frac{2 RT}{6\pi N^{0.67} \mu_L (V - b)^{0.33}}$$
 (10)

where b is van der Waals' volume; D_L is liquid diffusivity in the Stokes-Einstein range; and R is the universal gas constant.

Effect of Temperature

Data indicating the temperature dependency of $D_{\scriptscriptstyle L}$ are rather scanty for most substances, and when such data are available, they often consist of only two or three measurements at temperatures close together.

One generalization that was noted early is that systems with larger $D_{\scriptscriptstyle L}$ values always exhibit smaller temperature coefficients. Of the five specific methods discussed below for extrapolating a known value of $D_{\scriptscriptstyle L}$ at one temperature to other temperatures, the first three are recommended.

1. Use $D_L \mu/T =$ a constant, as indicated by the Stokes-Einstein equation for a given solute-solvent system. This approach results in:

$$\frac{(D_L)_2}{(D_L)_1} = \left(\frac{T_2}{T_1}\right) \left(\frac{\mu_1}{\mu_3}\right) \quad (11)$$

This equation is well-founded in theory and has been tested and proven satisfactory over rather wide ranges of T, D_L and μ . The maximum variation of the group $(D_L \mu/T)$ about the average value would be not expected to exceed about ±6%. Usually the variation is nearer ±2%.

2. Absolute reaction rate theory 32 suggests that diffusion is a rate process which varies exponentially with temperature:

$$D_L = Ae^{B/T} (12)$$

which means that a plot of $\log D_i$ vs. 1/T should give a straight line suitable for extrapolation. Such is indeed the case.

3. As pointed out by Kincaid, Eyring and Stearn, sa plot of specific liquid volume vs. either D_L/T or $D_L/T^{1.5}$; (preferably the latter,

probably) displays good linearity.
4. Othmer and Thakar* suggested that for water as solvent only, use be made of $D_{\iota}\mu^{\iota,\iota} = a$ constant. There is little to recommend this procedure.

5. Arnold suggested that for short temperature ranges:

$$(D_L)_i/(D_L)_0$$
 C. = 1 + bt (13)

where t is in deg. C.; μ_2 is solvent viscosity in centipoises at 20 C.; ρ_2 is solvent density in grams/cc. at 20 C.; and where b is defined as:

$$b = 0.020 \; (\mu_2/\rho_2^{0.67})^{0.5}$$

Concentrated Nonelectrolytes

Estimation methods for D_L discussed up to now were limited to dilute solutions of no more than a few % solute. For many substances, diffusivity changes little with concentration in dilute solutions, but beyond a certain concentration there is ordinarily a significant decrease of diffusivity with increasing solute concentration.

For ideal concentrated solutions it may be shown so, st that:

$$\left(\frac{D_{L1}\mu}{T}\right)_{cone.} = \left(\frac{1}{F_{1}'} - \frac{1}{F_{2}'}\right)x_{1} + \frac{1}{F_{1}'}$$
(14)

where $F_{1}' = (T/D_{L1}\mu_2)$ of 1 in a dilute solution of 1 in 2; F'_{z} = $(T/D_{L2}\mu_1)$ of 2 in a dilute solution of 2 in 1; and $(D_{L1}\mu/T)_{cone.}$ is the value of the group in a solution of mole fraction x_1 , with μ referring to the solution and not the solvent alone. Subscripts 1 and 2 denote solute and solvent, respectively.

For nonideal concentrated solutions, the right side of Eq. (14) should be multiplied by:

$$\frac{d (\ln a_1)}{d (\ln x_1)} = 1 + \frac{d (\log \gamma_1)}{d (\log x_1)}$$
 (15)

where $a_i = \text{activity of } l = x_i \gamma_i$; and y, is the activity coefficient of comnonent 1

Although results to date indicate the approximate validity of these equations, they have not been applied to many systems, and an improved theory of diffusion in concentrated liquid solutions is probably needed.

Diffusivity of Electrolytes

Nernsts derived a theoretical equation for completely dissociated electrolytes in very dilute solutions:

$$D_L = 8.314 \times 10^7 \times$$

$$\frac{UV}{U+V}\left(\frac{1}{u}+\frac{1}{v}\right)T\tag{16}$$

where U and V are absolute velocities of cation (+) and anion (-), respectively under a force of 1 dyne at infinite dilution.

Ionic velocities U and V may be obtained from the table on the previous page, as given by Treybal.35 This method is not applicable to weak electrolytes where solutions consist of a mixture of ions and large numbers of undissociated molecules.

For electrolytes, D_L initially decreases with solute concentration, passes through a minimum and then increases at higher concentrations. Because of this, and because of the restriction on Eq. (16) to very dilute solutions, calculated values of D, usually exceed experimental values determined at low but finite concentrations; at 0.1 molar, for example, calculated D_L values²⁷ for six electrolytes in water were higher than observed by 11% avg. and 31% maximum.

Calculation of D_L* at high concentrations necessitates consideration of ionic activity coefficients and of other generally unavailable data such as partial molal volumes. See work of Harned,36 Harned and Owen⁸⁷ and of Gordon,⁸⁵ for example, for more details concerning this area of calculation.

Ionic velocities listed in the table are for t = 18 C. only; where temperature coefficients are available, the empirical equation at the bottom of the table should be used. For other cases, $(D_L\mu/T) = a$ constant, Eq. (11) should be used, the same as for nonelectrolytes. Usually this is a good approximation, within ±5% or less, even for concentrated solutions.

The diffusion coefficients of solids in solids are the smallest of all, ranging from 1.0×10^{-11} to $11.0 \times$ 10-11 cm.2/sec. for various systems over a broad temperature range. For details we refer you to the two standard compendia, one by Jost** and the other by Barrer", which treat solid diffusion exhaustively.

Self-diffusion coefficients have been discussed above. For an illustration of an application of "surface diffusivities," see a recent paper by Gilliland, et al.41

A considerable amount of work has been done in recent years in the field of thermal diffusion, in both liquids and gases. Ninety references were located by this writer when he prepared a memorandum on thermal diffusion in 1954. For information on thermal diffusion coefficients, see, e.g., Robb and Drickamer, "; Furry and Jones," and Hirschfelder and coworkers.100

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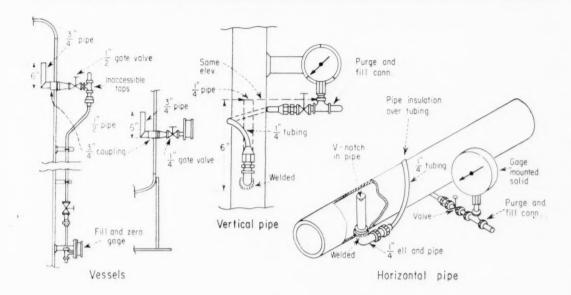
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PRACTICE . . .

DESIGN NOTEBOOK EDITED BY T. R. OLIVE



"Internal Seal Pots" Eliminate Gage Plugging

Here is a simple, inexpensive way to prevent the plugging of gages and recorders with materials that solidify on cooling.

★ Winner of the May Contest by

L. E. McLane

Assistant Plant Engineer, Bareco Wax Corp., Kilgore, Texas.

In refining microcrystalline waxes and asphalts, which have melting points in the range of 150 to 350 F., there is quite a problem with plugged pressure gages and recorders. A similar problem exists with other materials which solidify on cooling. Solution of the problem requires interposing a seal liquid between the process material and the gage.

The simple idea of using "internal seal pots" shown in the sketch eliminates the external seal pot. Hence, there is no need for an external source of heat for the pot, since it is surrounded by the heated process material. This keeps costs down by making expensive, custombuilt, slow-delivery sealed pressure gages unnecessary.

The sketch shows several types of installation making use of this

idea; taps at an inaccessible point on a high tank; accessible taps on a low tank; and taps on vertical and horizontal lines. The seal pot, placed inside the heated vessel or line, is simply a short length of vertical pipe.

Some of the seal liquids we have used include mixed and pure ethylene glycol, mercury, oils and solvents. For quick and easy filling and purging we use an ordinary 1-qt. lever-and-piston grease gun.

NEXT ISSUE: Watch for June Winner Announcement

★ How Readers Can Win

\$50 Prize for a Good Idea—Until further notice the Editors of Chemical Engineering will award \$50 each four weeks to the author of the best short article received during that period and accepted for Plant or Design Notebook.

Each period's winner will be announced in the second following issue and published in the third or fourth following issue.

\$100 Annual Prize—At the end of each year the period winners will be rejudged and the year's best awarded an additional \$100 prize. How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable non-winning articles will be published at space rates (\$10 minimum).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Design Notebooks, Chemical Engineering, 330 W. 42nd St., New York 36, N. Y.

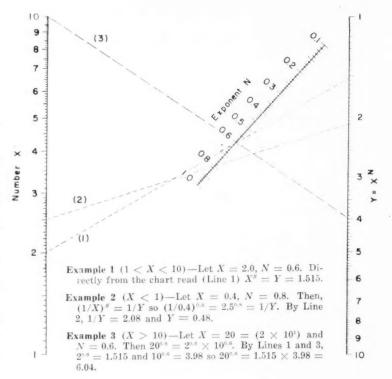
Calculate Fractional Powers By Chart

Bernard Liss

Air Reduction Co., New York, N. Y.

Calculation of the value of any number X from 1 to 10, raised to any fractional power Y between 0.1 and 1.0, can be handled quickly with this nomograph. In this range the application is direct. For numbers less than 1.0 the chart can be used by taking the reciprocal of X and taking the reciprocal of the resulting Y. For numbers greater than 10 express the number as a power of 10 (i.e., $20 = 2 \times 10^{\circ}$, $315 = 3.15 \times 10^2$). With the chart find (number) n and (10power) n and multiply the two values of Y together.

One common use for the chart is in cost estimation where scaling costs up or down is done by the formula $Y = X^s$, where N is generally taken as 0.5 to 0.7, and X is the capacity ratio.



Plastic Protection for Vessel Insulation

Paul N. Cheremisinoff

118

Alsynite Co. of New Jersey, Paterson, N. J.

Protecting the insulation on cylindrical vessels against weather, moisture and corrosion is usually done by trowling a coating over wire mesh, a laborious and timeconsuming procedure.

Here is a particularly simple method of covering the insulation

on cylindrical tanks, columns and towers: use of polyester fiberglass reinforced plastic sheeting, which comes in widths of 26, 34 and 40 in., and lengths to 12 ft.

I suggest the use of $1\frac{1}{4}$ or $2\frac{1}{2}$ -in. corrugated material since, when more than one sheet is needed for

the job, the corrugations of adjoining sheets can be overlapped to make a most satisfactory joint.

The sheets themselves have enough flexibility to be bent parallel with the corrugations down to as little as a 3-ft. radius around the tank. The plastic can then be secured in place with steel or other banding.

The chemical resistance of such plastic sheeting is usually good. Effects of certain corrosive materials are indicated in the table. Installations of this type are also resistant to weathering and so are successful out-of-doors.

Plastic corrugated sheeting comes in various colors which may serve the plant's color-coding scheme, in addition for providing esthetic possibilities. Furthermore, it needs no painting.

Chemical Resistance of Corrugated Plastic Sheeting*

	% Weig	ht Increase
		ht Increase———————————————————————————————————
	Immersion	Reconditioning Showing
Distilled water	0.59	None
Ethyl alcohol, 95%	0.92	0.18 Some
Sulfuric acid, 3%		
Sulfuric acid, 30%	0 . 28	Some
Sodium hydroxide, 1%		
Sodium hydroxide, 10%		
Toluene		
Sodium chloride, 1%	0 . 43	None
Hydrochloric acid, 10%	0.24	0 . 01 Few

^{*}Test procedure ASTM D543-52%. None of the reagents caused a change in dimensions; chlorine gas and hydrogen sulfide caused no change in any of these tests.

YOU & YOUR JOB EDITED BY R. F. FREMED

Are you investing your future in the right kind of company?

Are you working for smart bosses?



How to Measure Management Performance

Chaplin Tyler, Development Dept., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.*

When I think about the term "management" I include everyone from supervisor up to board chairman, including staff as well as line personnel. This definition embraces 10%, more or less, of all the people in an industrial enterprise—whether it be one that employs 100 people or 100,000.

Webster refers to management as "the collective body of those who manage ary enterprise or interest." By either definition, all of you reading this would qualify as management. All of you have management responsibility in some degree and in some particular, whether line or staff, whether generalized or specialized, whether at a high or a low level.

Although a great deal of attention has been given in the past 50 years to performance measurement, such effort has largely concerned individual productivity in the shop, office and field. We might call this the *microcosmic* approach to better performance. It is concerned with techniques of manufacture, clerical work and selling.

In the postwar years particularly, management has learned to analyze its own functions to uncover profit opportunities. This might be termed the macrocosmic approach to better performance and is concerned with what to manufacture rather than with precisely how to manufacture. It is in the area of management that I'd like to outline a number of approaches to performance measurement.

I know of 11 specific measures. They are:

- · Return on investment.
- · Profit margin on sales.
- · Growth
- Sales growth in a particular year.
- Long-range planning on a regular basis.
- How is each of the principal components of the business doing?
- Are goals specific? Are programs to achieve these goals specific?
 - Construction expenditures.
- Research and development manpower. How much? How is it deployed?
 - Organization.
- To what degree is the company's field being exploited?

Some of these measures are more qualitative than quantitative. Let's consider them in turn.

Orthodox Measures Are Financial

The orthodox performance measures are principally financial. Two in particular, % return on invest-

ment and % profit margin on sales are commonly used. Yet, neither of these measures tells much about the quality of management unless viewed over a relatively long period of years.

Much performance which looked good in the postwar decade undoubtedly was due more to the extraordinary demand situation in certain lines than to superior management skill.

An alternative approach is to use measures which underlie financial performance and which are more or less independent of the current business indicators.

One of these underlying factors is growth. In general, growth superior to that of the field in which a company competes is indicative of superior management. However, growth which merely reflects price inflation or which results from consolidation is not real growth. Thus growth should be judged on a relative as well as absolute basis. We need also to beware of growth which is achieved at the expense of profitability.

It's helpful also to analyze growth to identify contributing factors. Especially revealing is the % of sales in a particular year, say 1957, of products introduced commercially in a 10-yr. period, i. e., subsequent to 1947 in this case. A high

^{*}Based on a talk delivered at the first annual meeting, Mid-Atlantic Section, American Assn. of Cost Engineers. Meet your author on p. 140.

percentage indicates management's ability to induce innovation.

Since the flow of new products cannot be regulated from year to year, a new-products content is meaningless unless based on an extended period such as 5 years. In the chemical industry, 10 years is a more significant base.

Another mark of good management is the practice of long-range planning on a regular basis—looking ahead 5 years each year, supplemented by a 10-yr. estimate of the position of the business. Such a forecast might, for example, show the percentage of expected newproduct sales, comparing this with previous performance and forecasts to see whether the trend is up or down.

A consistent downtrend might be a danger signal, possibly indicating lack of a dynamic research program. An index of this sort can be used as a basis for corrective action before too much deterioration has occurred.

Beware of the Average

Another useful quantitative performance measure is an analysis of the business to find out how each of the principal components is doing. Such analysis may reveal that a good over-all average performance conceals one or more deteriorating lines needing attention.

In other words, beware of the averages!

Not infrequently a business will have an extraordinarily profitable line, the earnings share of which, when deducted from total earnings, discloses mediocre performance in other lines which may comprise the larger portion of the total investment. The longer such situations go unattended, the more serious they become.

Referring again to long-range planning, a qualitative measure of management performance is the degree to which goals are specific; and equally important, the degree to which programs for attaining goals are specific. Lacking such specificity, long-range plans are hardly more than hopes.

A common objection to longrange planning is that future performance cannot be predicted accurately. Admitting immediately the fallability of prediction, the value of careful and imaginative planning is not so much in the figures as such as in the effort necessary to obtain them. As many managements are discovering to-day, disciplined thinking and action are constructive exercises, not only for those down the line but also for those at the top.

A more tangible indication of future growth is construction expenditure. Industrial growth requires investment, and investment means construction and the resulting necessary working capital.

Depending on the lead time, current construction foreshadows future sales. In the chemical industry, for example, authorization of a major construction project in 1958 might mean a startup in 1960 and profitable commercial operation by 1961 or 1962. Thus, to realize the benefits of new capacity, planning must be done at least 3 or 4 years in advance.

Research As a Measuring Tool

Just as investment is a precursor of sales, so research is a precursor of investment. Consequently, another measure of management performance is the amount of research and development manpower and how it is deployed. Analysis of the various projects may indicate as long as 10 years ahead the possibilities for investment and, to a degree, how much money will be required.

To be worthy, a research program should be balanced in the sense that product health is maintained while at the same time future products are being scouted.

Organization: A Neglected Area

Another measure of management performance is organization. Most businesses have organization problems but don't recognize them as such. For some reason, managements will blame man failure, the engineer shortage or business conditions before they will recognize a faulty organization structure.

In one instance, a business seemingly was much undermanned. Analysis, however, showed, that the real difficulty was an archaic organization structure complete with overlapping activities, lack of delegated authority and inadequate descriptions of relationships among individuals and groups.

Next Issue-

Now brainstorming can solve problems in engineering.

Organization is perhaps the most neglected of all management's problem areas. Yet organizational muddles frequently are rationalized by such cliches as, "Men of good will will find a way to work together." But as one realist remarked, "They will work together if they understand what they are supposed to do."

Still another performance measure is the degree to which a company's field has been exploited. An enterprise might look upon its field as being three-dimensional: first, one of length in terms of the number of products it might make; second, one of breadth in terms of markets served; third, one of depth in terms of market penetration.

A three-dimensional analysis such as this is a good measure of management's effectiveness in cultivating a field.

The accent on new products is generally so pronounced that maintaining the health of established products is too frequently overlooked. There is nothing particularly glamorous about cost reduction or quality improvement or economic expansion. Nevertheless, the surest was to long-run financial results is attention to business at hand while indulging in dreams of the future.

There You Have It

I have mentioned 11 specific measures of management performance, some quantitative and some qualitative. There is, however, another entirely different approach to the subject, one that is purely philosophical: It has nothing to do with numbers or weights but is nevertheless a significant indicator of the soundness of an enterprise.

I refer to management's comprehension of its own responsibilities and the degree to which such responsibilities are discharged. These may be regarded as cyclical, starting with planning. Next comes organizing and operating. Finally, there is the review and measuring phase. From the measurements obtained, the cycle is completed again entering the planning phase.

There you have the measuring yardsticks that you can put up against the performance of your management. Are you working for smart bosses? Are you investing your career in the right company? Will the return on your investment

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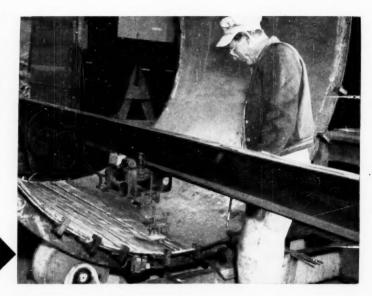
CHEMICAL ENGINEERING-June 30, 1958

CORROSION FORUM EDITED BY R. B. NORDEN



Unique lead cladding technique first calls for a dip in molten lead.

Automatic machine at construction site speeds cladding, needs unskilled labor.





Lead bonded sections are bolted together, producing a low-cost flue for carrying hot sulfur gases.

Automatic Lead Cladding Slashes Costs

A novel construction technique—with a strong do-it-your-self flavor—promises much lower costs for lead clad equipment.

By using an automatic lead cladding machine in the field, Consolidated Mining and Smelting Co. of Canada (Cominco) clads steel with relatively unskilled labor eight times faster than older hand methods. (Clad sections are welded together). Also the technique is proving to

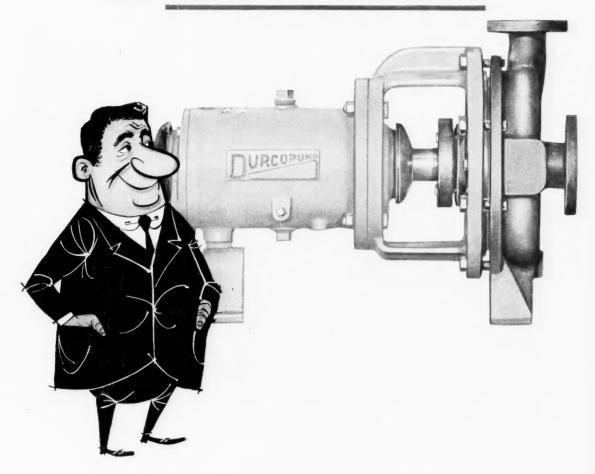
be much lower in cost than buying lead clad equipment from a fabricator and having it shipped to the construction site.

Developed by Knapp Mills (N. Y. C.), the automatic machine travels along an I-beam at a predetermined rate, carrying from one to ten burning heads. It melts a strip of lead about 6-in. wide by \$\frac{1}{2}\$-in. thick at the rate of 1 ft./min. per pass. This lead is metallurgically bonded to the steel.

One machine can lay down 36-40 sq. ft. of lead clad steel in a day. It's estimated that lead clad ducts can be made for about \$3.50-\$5.00/sq. ft. using automatic machines. This, of course, depends on size and type of ducts and other specifications. Prices would range from \$18-\$25/sq. ft. when ducts are purchased from a fabricator using hand lead burning and bonding methods.

Use of the machines at Trail,

THE PUMP THAT'S CLOSEST TO MY HEART AND MORE DEPENDABLE!



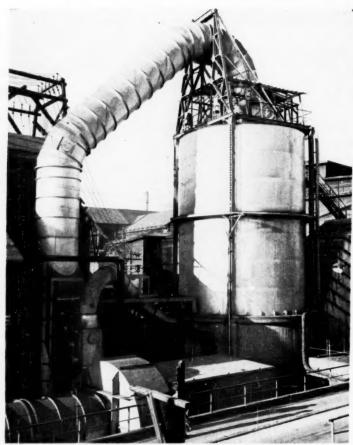
Series H Durcopumps are designed and built to give maximum service at minimum overall cost when handling severely corrosive solutions. These pumps are built with capacities from ½ to 3500 gpm, and with heads to 345' They are available in twelve standard corrosion resisting alloys. When you are looking for a better chemical pump, look to Durco.



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COOLING tower calls for tricky lead bonding and lead lining techniques.

B. C. points up where and how automatic cladding can really pay off.

Cominico had to replace an obsolete wooden humidifying flue containing water sprays, which carried SO2 gases from a lead roasting operation. This flue was used to cool and condition sinter gases prior to electrostatic precipitation. But it usually developed air leaks which greatly increased the gas volume to be treated. Cominico engineers decided to put in a circular steel duct, 300 ft. by 9 ft. in dia. From the duct, gases are forced into a 30-ft. dia. tower for a water spray treatment prior to precipitation.

This system must convey hot

gases with 3% SO₂ and a high dust content at temperatures up to 400 F. Periodically it has to be cooled down for cleaning.

Stainless and masonary, glass or enamel-lined steels were too expensive for this service. Also it wasn't possible to use inexpensive sheet lead. Most sheet lead installations can only take temperatures up to 200 F., where there is little temperature fluctuation. Above 200 F. sheet lead (supported by steel straps) tends to creep between supports. Ultimately sheets buckle and crack. Brick facing on lead linings provides some insulation and support, but costs are high and the creep problem, while not as severe, remains.



INTERIOR of cooling tower shows upper lead clad, lower sheet lead.

► Cladding Overcomes Objections-Lead clad (or lead bonded) steel overcomes these objections. Metallurgically bonded to steel, there is no creep problem, and this type of construction can take temperatures up to 500 F. However. the usual cladding techniquesmainly melting lead strips on steel with a lead burning torch -are slow and expensive. Also costs for shipping in lead clad sections would have been prohibitive.

The answer proved to be Knapp's automatic cladding machine. Lead cladding was applied to cylindrical sections of steel at the construction site (9-ft. dia., 8 ft. long units). Internal surfaces of these cylinders were cleaned, fluxed, and then given a first coating of lead by rotating in a shallow bath, so the surface of the steel dipped into the molten lead. No lead adhered to the unfluxed external steel surface.

Main coating of lead, about 10 lb/sq. ft., was then applied. Sections were welded into units about 50-ft. in length, and the internal lead cladding applied over the welded joints by hand burning. These sections were provided with end flanges, transported to the site and erected. Flanges were bolted up, and the cladding over the joints "burned" together.

► Cooling Tower Gets Clad— The cooling tower was of lead clad mild steel, supported by a concrete sill and base. Mild



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To handle the highly corrosive brine used in regenerating this Cesco Water Softener, two lengths of Uscolite thermoplastic pipe are used. Uscolite is so highly resistant to the brine that not one section of it has ever had to be replaced! And there's no possibility of electrolysis due to the use of dissimilar metals. In fact, Uscolite® Pipe remains in such perfect condition that when the water softener tanks require replacement, the pipes are removed and used in new units.

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*Patent applied for.

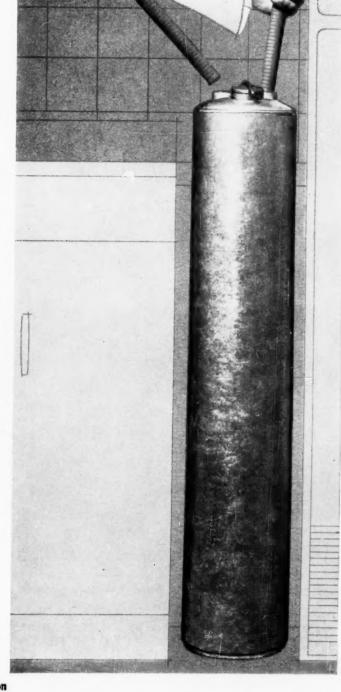


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steel plates were clad before construction, each plate spot welded to form a cylinder, then cleaned, fluxed and clad in the same way as the sections of the flue. Plates were partially flattened out with a ten ton hammer and a road roller, cut to size and welded in position. Cladding at the welded joints was sealed by cladding lead over the joints by hand methods.

Vertical walls of the lower concrete part were protected by 12 lb. sheet lead lining, welded to vertical supporting strips of lead inserted in the concrete. The floor was protected by sheet lead laid over the concrete, after the application of an intermediate dressing of asphalt. This was protected by a course of acid-proof brick, against the

possibility of mechanical damage when cleaning out accumulated sludge.

► No Cure-All — Cominco's experience—a major application—also points up that automatic cladding is no cure-all.

It's primarily designed for large-scale repetitive applications on simple sections. It cannot handle complicated parts. And, of course, it can't compete costwise against lead linings.

Knapp Mills is now planning to license the machine in the U. S. A typical arrangement would call for a flat yearly royalty, where the user would build the machine from drawings and specifications supplied by Knapp. A typical cladding machine for ducts costs about \$300 to build.



Now You Can Spray On Hard Tungsten Carbide

Irregular shapes and flat surfaces can now be coated with hard erosion-resistant tungsten carbide, according to Kennametal, Inc., Latrobe, Pa. The company has just introduced a new hard-surfacing powder with a high tungsten carbide content.

It can be applied to steel parts by hand-held or mechanicallyheld metal spraying equipment. The part and coating are then heated by an oxyacetylene torch or in a furnace to fuse the coating to the base metal.

Surface coating (0.010 to 0.90-in. thick) cannot be machined but can be ground on diamond or silicon carbide wheels to close tolerances.

Two New Aluminum Alloys

A new aluminum sand casting alloy, which combines high strength and excellent ductility, has been announced by Aluminum Co. of America.

Dubbed alloy X250-T4, the metal does not require special quenching techniques for high tensile strength. It has the same tensile properties as the older alloy 220-T4, but higher resistance to stress corrosion.

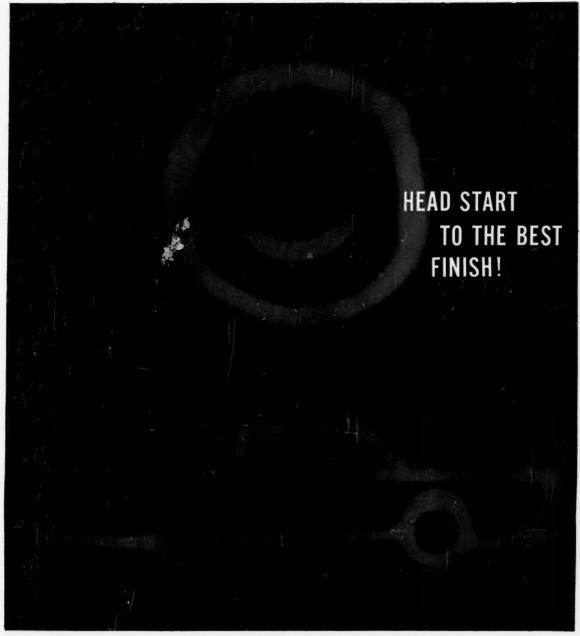
Applications should include aircraft structural eastings, equipment subject to impact loads and equipment in the dairy, food and chemical industries.

On the nuclear power front, Argonne National Lab. has developed a new aluminum alloy which they believe will reduce the cost of producing nuclear power.

The experimental alloy—called X-8001—will be used as a protective jacket or cladding for fuel elements in the Argonne Low Power Reactor (ALPR). This is a prototype of a portable boiling water reactor for power generation and space heating in remote regions.

Alloy X-8001 was developed by adding small amounts of nickel to aluminum 1100, a commercial alloy containing iron. Present cladding materials, such as zirconium, are much more expensive and difficult to fabricate than aluminum. But commercial aluminum has poor corrosion resistance to water above 400 F. due to hydrogen penetration into the metal. The trick was to add an alloying material which would prevent this penetration.

Below 400 F. aluminum has a relatively low corrosion rate. Above 400 F. corrosion shifts to a vigorous penetrating attack, with the formation of mixed metal and oxide. This weakens the metal and it rapidly converts to the oxide at temperatures around 600 F. Argonne metallurgists believe that hydrogen, produced in the corrosion process, is primarily responsible for this accelerating type of attack at higher temperatures. The addition of small amounts of nickel appears to block H, attack.



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CHEMICAL ENGINEERING-June 30, 1958

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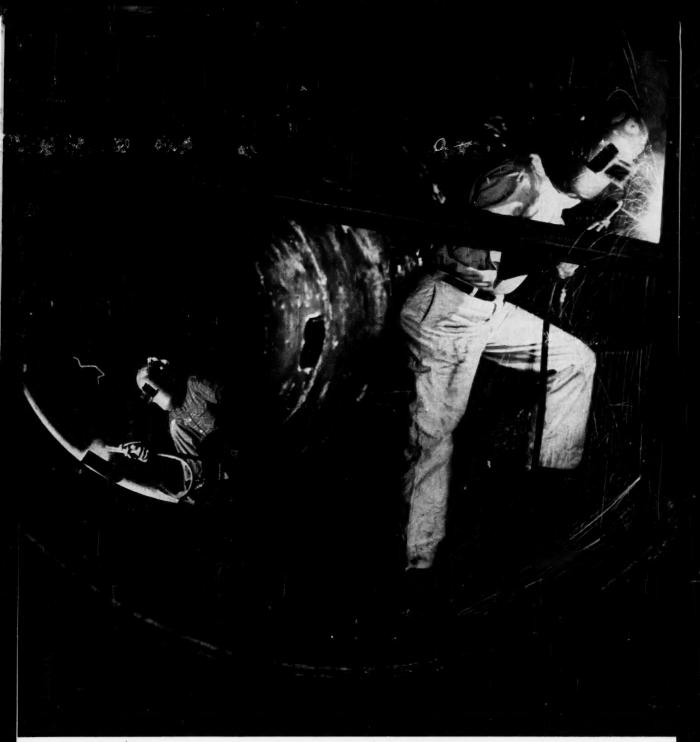
- Recognizing Your Special Hazards
- The Fire Triangle in Special Hazard Fire Protection
- Special Hazard Fire Terms Defined
- Water Spray Systems
- Selfcon Water Spray Systems
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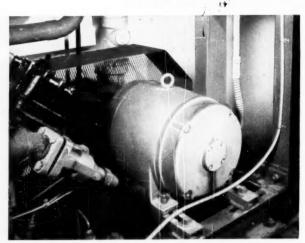
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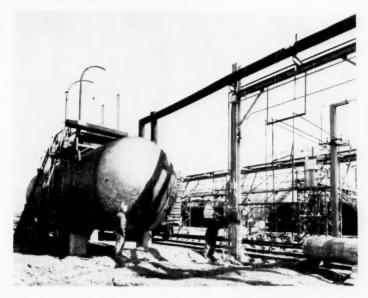
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FIRMS IN THE NEWS

NEW FACILITIES



Plant Startup Ushers in Boron Fuel Production

Workmen put finishing touches on a nitrogen tank used in making HEF-2 (boron-based high-energy fuel) now being produced for the Navy at Olin Mathieson's new \$4.5-million plant at Niagara Falls, N. Y. Adjacent to new unit, construction continues on the \$45-million Air Force plant slated to be finished some time next year.

Monsanto Chemical Co.'s Plastics Div. is doubling production capacity for Lytron 680, an acrylic binder for latex paints, with a plant expansion at Springfield, Mass. Completion is scheduled for this month.

Linde Co. is building a "recordbreaking" 730-million-cu.-ft./ mo. oxygen plant at the Duquesne Works of U.S. Steel Corp.; unit will produce 99.5% pure oxygen.

Texas Gulf Sulfur announces production startup of a new Frasch sulfur facility at the new Fannett Dome in Jefferson County, Tex. Annual capacity is in neighborhood of a half-million tons.

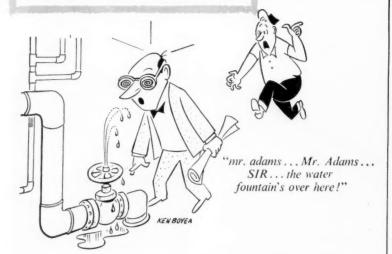
Ludlow Papers, Inc., is planning to locate a new plant at Orange, Tex., for making clear polyethylene film. Unit will be located near Spencer Chemical's resin plant at Orange (Spencer recently made a similar arrangement with Crown Zellerbach—see above).

Crown Zellerbach Corp. is increasing capacity for polyethylene film by building a new plant at Orange, Tex. Plant is part of a long-term agreement recently signed with Spencer Chemical; C-Z's new facility will be supplied with polyethylene resin from adjacent Spencer plant now in production.

Southern States Co-operative will erect its first granular fertilizer plant—with annual capacity of about 60,000 tons



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FIRMS . . .

—near Russelville, Ky. Unit will cost upwards of \$750,000 and is expected to be on stream by next spring.



General Electric has installed a large helium wind tunnel at its research laboratories in Schenectady, N. Y. Vacuum pumps for the helium tunnel shown above fill an entire room in laboratory's basement

Petro-Tex Chemical Corp.'s 200,000-ton/yr. butadiene plant at Houston, Tex., has been re-engineered to accommodate either n-butane or n-butylene as starting material. Unit is now producing butene and aviation gasoline alkylate as well as butadiene.

Atlas Powder Co. has dedicated its new \$3-million technical center at Wilmington, Del., next to firm's general office. New center will house company's basic research and product development activities.

U.S. Lime Products Corp. has opened a \$2-million manufacturing plant in Arrolime, Nev., 19 miles northeast of Las Vegas. Increased lime processing capacity will meet rising demand of metallurgical, paper and chemical producers in the Western states.

Shell Oil Co. has started up at firm's Anacortes, Wash., refinery the first sulfuric acid alkylation unit to be erected in the Pacific Northwest. Multimillion-dollar unit will pro-

duce 800,000 bbl./yr. aviation gasoline.

Amoco has added a second Ultraforming unit at its Texas City refinery. New unit's 21,-000-bbl./day output doubles Ultraforming capacity.

Stauffer Chemical Co. has completed plans for a \$100,000 process development laboratory at its Richmond, Calif., research center. Unit is scheduled for occupancy by end of September.

Cook Chemical Co. plans to open an affiliate plant in Puerto Rico to produce polyethylene insecticide sprayers that will then be shipped back to company's plant in Kansas City. Firm cited tax exemptions and labor availability among reasons for shift to Puerto Rico.

Magnolia Petroleum will build a 150-million-cu.ft./day gas processing plant at Cameron Meadows, La., near Gulf of Mexico. One novel feature of plant is that distillate will flow to company's Beaumont refinery under pressure from processing operation and will not have to be pumped. Target completion date is April 1959.

Reichhold Chemicals has drawn up plans for a \$1-million deep-water terminal on the ship channel at Mobile, Ala. Terminal will be able to handle several million gallons of liquids as well as bulk handling of dry chemicals.

Du Pont has opened a new laboratory for customer service and for evaluation of new products of the Electrochemicals and Pigments departments. Cost of the new facility in Wilmington, Del., was around \$5 million.

Knox Glass has started production at its new \$750,000 amber glass manufacturing facility at firm's Palestine, Tex., plant. New furnace, fabricating machines and annealing ovens increase production capacity by 40%.

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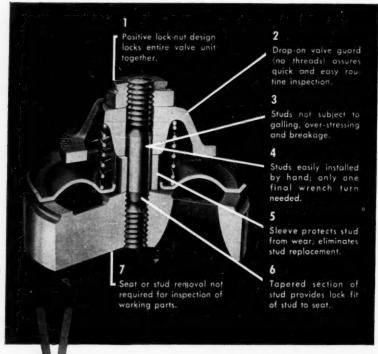


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Incorporating seven points of superiority, the new valve features a tapered or V-shaped stud which screws down tight to the seat. This exclusive design anchors the stud, eliminating any possibility of galling, over-stressing or breakage. What's more, the new self-locking nut and drop-on guard assure quick and easy inspection of working parts-without stud or seat removal.

Remember: In the DURABLA Valve, only "point contact" is made by the valve member on the stud sleeve, so it can't bind or hang-up. The open-type guard assures free flow of liquid, prevents clogging.

These stainless-steel valves operate freely under temperature extremes, with corrosives, and in any position. Made in 15 sizes to fit any reciprocating pump, old or new.
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FIRMS . . .

Columbian Carbon Co. will have additional facilities for all phases of research on carbon black, pigments and related fields when new million-dollar building near Princeton, N. J., is completed later this year.

Kennecott Copper Corp. is scheduling improvements to the tune of 7-8 million dollars at its recently acquired copper smelter at Garfield, Utah. Among plans is a boost in capacity to around 21,000 tons/mo. electrolytic copper. Changes will start when Kennecott takes over on Jan. 2, 1959.



Stauffer Chemical Co. has acquired all outstanding stock of Anderson Chemical Co. of Weston, Mich. Anderson produces and markets a number of specialty chemicals including esters of boron and silicon. Stauffer plans to intensify research and development in organic compounds of boron and silicon.

Cutter Laboratories and Hollister-Stier Corp., two western drug firms, have concluded a merger agreement. Under merger, Hollister-Stier's country-wide service to physicians is combined with Cutter's extensive research facilities.

Yuba Consolidated Industries has purchased the stock of Weber Engineered Products of Cincinnati, Ohio. Weber manufactures a wide line of outdoor power equipment including power lawnmowers and tiller mowers.

Hagan Chemicals & Controls, Pittsburgh, Pa., has acquired the name and tangible assets of The Kybernetes Corp. of New York, N. Y. Kybernetes manufactures automatic data logging and temperature monitoring equipment.

CALENDAR

Gordon Research Conference, ganic Coatings, New Hampton School. July 7-11 New London, N. H.

Gordon Research Conference, Chemistry and Physics of Isotopes, Kimball Union Academy. July 7-11 Meriden, N. H.

National Academy of Sciences-Na-tional Research Council, Interna-tional Congress of Radiation Research July 10-16 Burlington, Vt.

Gordon Research Conference, Corrosion, Colby Junior College.
July 14-18 New London, N. H.

Gordon Research Conference, Organic Reactions and Processes, New Hampton School. July 14-18 New Hampton, N. H.

American Farm Research Confer-ence, Purdue University. July 16-18 Lafayette, Ind.

International High Polymer Confer-ence, University of Nottingham. July 21-24 Nottingham, England

Gordon Research Conference, Statistics in Chemistry and Chemical Engineering, New Hampton School. July 21-25 New Hampton, N. H.

Gordon Research Conference, Chemistry at Interfaces, Kimball Union Academy. July 21-25 Meriden, N. H.

Technical Association of the Pulp and Paper Industry, 13th Engi-neering Conference, Multnomah July 28-Aug. 1 Portland, Ore.

Gordon Research Conference, In-strumentation, Colby Junior Col-July 28-Aug. 1 New London, N. H.

Gordon Résearch Conference, Elas-tomers, Colby Junior College. Aug. 4-8 New London, N. H.

Gordon Research Conference, Radiation School. Chemistry, New Hampton Aug. 4-8 New Hampton, N. H.

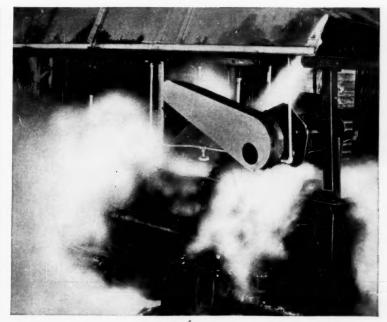
Western Packaging and Materials Handling Exposition, San Fran-cisco Civic Auditorium. Aug. 11-13 San Francisco, Calif.

Gordon Research Conference, Chemistry and Physics of Metals, Kimball Union Academy.

Aug. 11-15 Meriden, N. H.

American Institute of Chemical Engineers-American Society of Mechanical Engineers, Second National Heat-Transfer Conference, Edgewater Beach Hotel.

Aug. 18-21 Evanston, Ill.





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Pressure-operated for greatest dependability, Kidde systems use no falling weights, no clumsy mechanical triggering methods. Special rateof-temperature-rise detectors trigger the system at the first sign of fire, pneumatic control heads insure instantaneous and complete carbon dioxide discharge. Automatic electric actuators also are available. In a Kidde system, all moving parts are self-enclosed for safety, and visual indicators show at a glance whether the system is "set" or "released."

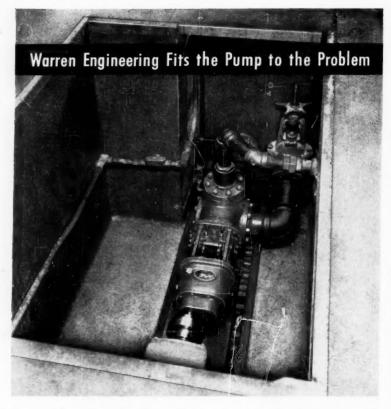
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Walter Kidde & Company of Canada Ltd. Montreal — Toronto — Vancouver



Abrasive quality of insulating paint was death on pumps...until Warren engineers suggested this special Warren Screw Pump.

What type of pump will best handle an extremely abrasive and

After wearing out one pump in a few hours, another in a few weeks . . . a large manufacturer of electrical equipment sought the help of Warren engineers. The solution was the Warren \$31/2 External Gear and Bearing Screw Pump pictured above.

It wasn't delivered "off the shelf," though. Warren engineers suggested several special experience-proven features to prolong the life of the pump against the abrasiveness of the widely-used and highly efficient insulating paint. And it was designed to handle 40 GPM at 60 PSI discharge pressure at 32,000 SSU viscosity at 420 RPM.

Although the pump was installed deep in a pit, over a year ago, maintenance has been no problem - because there has been no need for it. A thorough inspection after 1900 hours' operation showed no wear. Warren

engineers have again fitted the pump

to the problem.

Here is another Warren #31/2 External Gear and Bearing Screw Pump recently installed in the same plant.

> For detailed information on Warren External Gear and Bearing Screw Pumps, write for Bulletin S-206.



WARREN PUMPS, INC.

WARREN, MASSACHUSETTS

PEOPLE . . . TECHNICAL

Simplifying the 8 Sign

MONEY AND THE CHEMI-CAL ENGINEER. By James O. Osburn and Karl Kammermeyer. Prentice-Hall, New York. 201 pages. \$6.00.

When a writer attempts to explain to a neophyte as complicated a subject as chemical engineering economics, he must walk a precarious tightrope. On one hand, he must stick to basic fundamentals and use simple language. On the other hand, he runs the risk of over simplifying the subject by the use of unwarranted generalizations and unrealistic examples.

Professors Osburn and Kammermeyer (Univ. of Iowa), in turning out a highly readable and interesting book, have erred somewhat on the side of oversimplification. This is understandable in view of the objective stated in the preface: "It does not try to cover the whole field of economics, but rather to give a working knowledge of the chief principles and to stimulate the practice of seeking out references for more detailed considerations of specific points."

In the hands of a good teacher who knows the subject, this book will probably be adequate for inof struction undergraduate chemical engineers. To young engineers reading it for self-instruction, however, we would reemphasize the old proverb that a little learning can be a dangerous thing. Fortunately, the published literature today abounds with help for the engineer seeking a deeper understanding of the fine points of engineering economics.

Despite its shortcomings, the book has much in its favor. It is well organized, as indicated by the sequence of chapter headings: It Takes Money; Repeated Costs; Getting Your Money Back; Design for a Profit; Operate for a Profit; The Economic Side of Process Design; Spending to Save; The Decision to Invest; Checking Up. Writing style is light and pleasant, much like

BOOKSHELF

Prof. Osburn's recent contributions to our CE Refresher. Quality of typography and illustrations is excellent.

According to the publisher's jacket blurb, "The authors show you . . . how to insure that your business will reap a profitable return." If this claim were true, this book would become a bestseller overnight. We predict a more modest success for this Osburn-Kammermeyer opus. -CHC

BRIEFLY NOTED

AMERICAN PETROLEUM INSTI-TUTE CATALOGUE OF PUBLICA-TIONS AND MATERIALS. 58 pp. Publication Section, American Petroleum Institute, 50 W. 50 St., New York 20, N. Y. Free. Contains thumbnail descriptions of each publication, with code number, cost and specific instructions on how to place your order.

ATOMIC ENERGY COMMISSION RESEARCH REPORTS PRICE LIST No. 29. Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Free. Gives cumulative listing of more than 4,000 unclassified AEC reports in OTS collection, including new documents acquired since Aug. 1957.

BIBLIOGRAPHIC SURVEY OF CORRO-SION 1954-1955. 468 pp. National Association of Corrosion Engineers, 1061 M & M Bldg., Houston 2, Tex. Members: \$15; nonmembers: \$20. Compiles 4,287 abstracts of articles on corrosion and corrosion prevention published in 1954-1955.

PRODUCT DIRECTORY OF THE RE-FRACTORIES INDUSTRY. Refractories Institute, First National Bank Bldg., Pittsburgh 22, Pa. \$3. Lists 2,700 brands of refractories produced by 185 manufacturers, is cross-indexed by company, plant location, product division and brand name.

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These products will give you permanent plant-wide protection against corrosives.

Write for Bulletin CC-3.



PEOPLE ...

MEET YOUR AUTHORS

M. A. GIBBONS



Luther D. Loch

ABOVE 2500 F., WHAT MATERIAL TO USE? PAGE 105.

Luther D. Loch is principal ceramist in the basic research branch of the Carborundum Co., Niagara Falls, N. Y.

Loch's previous industrial experience included work with a wide variety of materials problems, for Corning Glass Works and Battelle Memorial Institute.

For Carborundum, Loch has worked mostly in applied research and process development, largely on high temperature and nuclear problems. At present, he's responsible for guiding the work of a group doing fundamental studies in high-temperature chemistry and ceramics.



M. Dmytryszyn

COMPUTER SPEEDS ECONOMIC EVALUATIONS. PAGE 99.

In October 1957, M. Dmytryszyn became a project leader in charge of the economic and engineering evaluation group in the organic research department, Monsanto Chemical Co.

He originally joined Monsanto ten years earlier, as a member of the research department of the organic chemicals division. Since that time, he has done process development and production work in the pilot plant and interim manufacturing departments.

Dmytryszyn graduated in chemical engineering in 1947 from Washington University. While holding down his full-time post at Monsanto, he attended Sever Institute of Technology, and received a master's in chemical engineering in 1949 and his doctorate by 1957.



W. L. Massey, Jr.

COMPUTER SPEEDS ECO-NOMIC EVALUATIONS. PAGE 99.

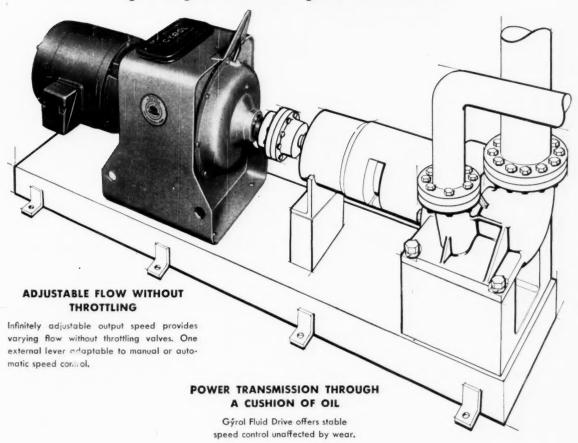
Since April 1956, W. L. Massey has been working for Monsanto Chemical's applied mathematics section, research and engineering division.

Principal efforts have been in the field of statistics and operations research of which the current article is one example.

Before joining Monsanto, Massey worked four years as market research director and sales analyst at Rice-Stix, Inc. Later, he served as an applied science representative for IBM. where he assisted in the installation of the first IBM 702.

Massey earned an A.B. degree in mathematical statistics from St. Louis University in St. Louis.

American Blower *Gýrol** Fluid Drive makes pumps more productive!



Fact is, a Gýrol Fluid Drive can benefit any process requiring adjustable control of pump flow and pressure.

By providing *stepless speed control* without wasteful throttling, it reduces power consumption and pump work-load, keeps maintenance costs to a minimum. The problem of handling liquids at varying viscosity and density is greatly simplified.

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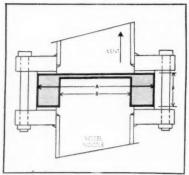
Any standard pump driven by a constant-speed motor can be equipped with Gýrol Fluid Drive. Type VS, Class 2 Unit (shown here) comes in a complete range of sizes from 1 to 800 hp. Other designs handle up to 12,000 hp. So if you want to save power and reduce equipment and maintenance costs on pumping jobs that involve varying capacities . . . consider American Blower Gýrol Fluid Drive.

For full information, contact one of our 73 branch offices. Or write: American-Standard,* American Blower Division, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ontario.

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... accurate to \pm 5% of rated burst, (ratings under 10 psi provide 1 pound or closer tolerance).

Mount in standard A.S.A. flanges, (no special holders required).

Virtually universally corrosion resistant.

Burst rating essentially constant at all temperatures.

Complete rupture of membrane provides full vent opening.

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Recommended for use at 75% of rated burst.

These are the features inherent in the new Impervite non-metallic frangibles. In addition, Impervite disks are non-contaminating, unaffected by thermal shock, and are suitable for use with gas or liquid for burst settings from full vacuum to 300 psi at temperatures to 650°F. Over 130 combinations of sizes and burst ratings carried in stock for immediate delivery.

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AUTHORS . . .



Ning Hsing Chen

NEW, FAST, ACCURATE METHOD TO FIND TUBESIDE HEAT TRANSFER COEFFICIENTS. PAGE 119.

Process engineer Ning Hsing Chen is with the M. W. Kellogg Co., in Jersey City, N. J.

Industrial experience for the past several years includes a variety of posts as process engineer, job engineer, project engineer in the field of petroleum refining, coke oven gas refining, resin and plastics technology, and petrochemical plant design.

Chen earned a bachelor's degree in chemical engineering from Brooklyn Poly in 1949. The following year, he added a master's in chemical engineering from the University of Missouri. Since that time, he has been working on a part-time basis toward his doctorate.



Chaplin Tyler

HOW TO MEASURE MANAGE-MENT PERFORMANCE. PAGE 119.

DuPont's Chaplin Tyler joined the Wilmington firm over 30 years ago. His various posts have included research supervisor, research division head, sales development manager, director of public relations and development department staffer.

Before he joined DuPont, he worked for three years as an assistant editor on *Chemical Engi*neering and for four years in re-

search posts at MIT.

Consulting assignments over the years have included projects for the President's Materials Policy Commission, Northeastern University Corp., and the Delaware Technical Advisory Committee, Selective Service System.

Tyler earned his B.Ch.E. from Northeastern University in 1920. Later, in 1922, he picked up a B.B.A. from Boston University and, the following year, he went on to get an S.M. at MIT.



J. F. Adams

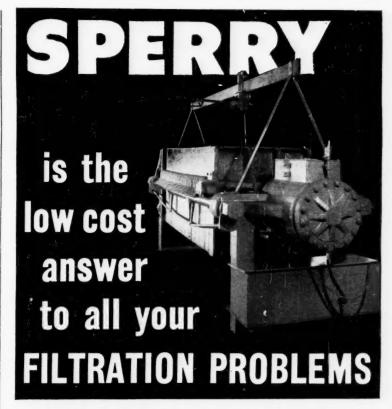
COMPUTER SPEEDS ECONOMIC EVALUATIONS. PAGE 99.

Since last October, J. F. Adams has been pilot plant supervisor at the J. F. Queeny plant of Monsanto Chemical Co., in St. Louis, Mo.

He originally joined Monsanto in September 1942. The following year, he transferred to the research department of the organic chemicals division. Since that time, he had done process development work in the research laboratories and has also worked in the pilot plant and interim manufacturing departments.

Adams earned his chemical engineering degree in 1942 from the University of Texas. Later, he attended graduate school at Washington University.

He is a member of the publications committee of the American Association of Cost Engineers.



Consider all the money-saving aspects of a Sperry Filter Press. These include low initial cost...nominal installation...minimum maintenance...low depreciation...and an economy of operation that extends through many years of trouble-free performance.

However complex your filtration problems may be, these

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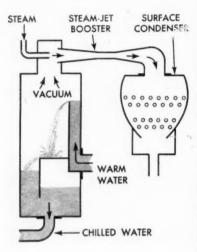
Texas Chemical Eng. Co.
4101 San Jacinto, Houston, Texas

CE-6

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In I-R Steam-Jet Coolers. water is the only refrigerating medium used!

Water and steam are all you need to provide a dependable supply of chilled water, at temperatures down to 35 F, when you use an Ingersoll-Rand Steam-Jet Refrigerating System.

There are no hazardous gases, no high pressure vessels or equipment, and no vibration. Water is chilled by evaporation in a vacuum chamber which is evacuated by a steam-jet ejector. Either barometric or surface condensers can be used, depending on the economics of the installation.

Advantages of this I-R system include safety, ease of installation, uninterrupted service, large overload capacity, low maintenance and ease of control. Combinations are available for any capacity between 30 and 1500 tons of refrigeration.

Send for Bulletin No. 9143-B



PEOPLE ...

LETTERS: PRO & CON

C. H. CHILTON

Carbide Man Is Loyal

I wish to take issue with your blanket statement regarding the morale of Union Carbide engineers in your March 10 Chementator (p. 69).

The statement implies that Carbide engineers as a group are dissociated from the Company and function as an entity outside the organization like so many machines. Speaking for myself, of course. I feel that in a small way I am responsible for the welfare of the Corporation as it is affected by my work. On that basis I consider your statement unwarranted.

None of the people with whom I associate recall being polled by a representative of your organization as to their morale in general or as a result of any specific corporate action. On that basis, your statement is irresponsible and lacking in judgment for a publication of presumably good ethics.

J. D. QUINN Union Carbide Chemicals Co. Torrance, Calif.

Error of Transmission

Your account of the settlement of the suit between National Cylinder Gas Co. and Catalysts and Chemicals Inc. (Apr. 21, p. 56) is incorrect and incomplete. Important features of this agreement consist of the following:

· CCI has a nonexclusive license to use essentially all the trade secrets, confidential information, processes and know-how of NCG as of Sept. 1, 1957, with respect to compositions, method of preparation, method of manufacture and application of cat-

• CCI agrees to pay NCG 21% of its gross sales of catalysts for a period of seven years and thereafter if it should be necessary for the total royalty to equal \$500,000.

• CCI agrees to license NCG to manufacture and sell catalysts that CCI has developed in its own laboratories prior to Dec. 31, 1959, which have been demonstrated in commercial operation to have a distinct advantage over competing catalysts. It is necessary to demonstrate that the subject catalysts are distinctly superior to competing catalysts, which provision, we believe, makes this part of the agreement almost unworkable. NCG agrees to pay CCI 21% of its gross sales on such catalysts for a period of six years.

· NCG has withdrawn all charges relating in any way to the ethics or character of any of the defendants.

We hope this information will

be of assistance to you in obtaining a factual account of the settlement of the suit.

R. E. REITMEIER Catalysts and Chemicals Inc. Louisville, Ky.

► We realize that Chementator stories are often incomplete. Function of that department is to report and interpret the highlights of significant developments, not details.

We do apologize for the single unfortunate error in the last paragraph of the published story. This mistake occurred in transmission of information by teletype from Pete Forbath in Chicago to Cecil Chilton in New York. Pete correctly wrote, "CCI may now use catalyst trade secrets." The teletype received in New York read, "CCI may not use catalyst trade secrets."—ED.

Add to BTX Producers

Sir:

In your article on "More Aromatics From Petroleum" (May 5, pp. 78-82), you list eight major producers of BTX from petroleum. Our name was omitted from this list.

Our company built the first Udex unit in operation and actually pioneered this field.

E. M. LUNDGREN Eastern States Petroleum

& Chemical Corp.

Houston, Tex.

► We're doubly embarrassed by this omission, inasmuch as we published a pictured flowsheet on Eastern States' Platformer-Udex operation back in May 1952 .- ED.



AO 484A VINYLITE MASK GOGGLE

for Chemical Splash Protection

Meet our new lightweight flexible mask goggle with a REDESIGNED, MUCH DEEPER MASK. You'll find it provides a better fit at the temples and nasal section than ever — while retaining the comfort of the previous model. Optically correct lenses can be removed and replaced as easily as formerly and have been curved slightly for improved angle of vision. Safe, indirect ventilation is provided, and lens fogging controlled by four ports. The 484A will fit over practically all types of personal glasses without being cumbersome. Quickly adjustable rubber headband.

Note: Clear frame, clear or green lens. If a *green* frame is desired with clear or green lens, ask for Model 485A.

Your nearest AO Safety Products Representative can supply you

Always insist on Trademarked lenses and frames



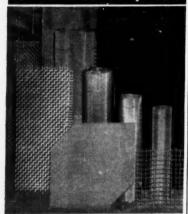
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AO 710 GOGGLE for Splash, Spray and Impact Exposures

Another lightweight, wide-angle vision goggle that will fit over most ophthalmic and safety prescription glasses. Particularly recommended for use in the chemical industry and in humid operations. While completely splash-proof (no vents in frame, no holes in lenses) tests show indirect ventilation makes it twice as fog-free as similar goggles. Lenses are impact resistant acetate — conform to highest safety and optical standards. Frame is molded from non-irritating, non-toxic vinylite plastic. All parts replaceable, including all-rubber headbands.

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OFFICES IN PRINCIPAL INDUSTRIAL CITIES

PEOPLE ...

NAMES IN THE NEWS

M. A. GIBBONS



Raymond E. Vener

M. W. Kellogg Co., New York, has announced the appointment of Raymond E. Vener as manager of industrial research.

Vener obtained his B. S. in chemical engineering from Villanova University and his doctorate from the University of Pennsylvania. Former associations include the Manhattan Project, Drexel Institute of Technology and Catalytic Construction Co.

He is particularly well known for his accomplishments in process engineering, particularly in the field of atomic energy.

Lloyd A. Nicolai has joined Esso Research and Engineering Co. as an assistant director in the firm's petroleum development division, Linden, N. J.

Ralph S. Binns has been named vice president of Carlisle Chemical Works, Inc., in addition to his present post as general manager of the firm's division, Advance Solvents & Chemical.

Aristid V. Grosse, president of the Research Institute of Temple University, and Elbert C. Lathrop, formerly with the U.S. Department of Agriculture, have been appointed as technical consultants to the staff of Armour Research Foundation.

George Rieger has been appointed director—market research and development for Amoco Chemicals Corp., Chicago, Ill.

B. B. Ashby and J. C. Dikson have been promoted to senior chemical engineers in Humble Oil & Refining Co.'s technical division, in Baytown, Tex.

George H. Potter and Alton H. Wallace recently joined the development department of Union Carbide Chemicals Co., in So. Charleston, W. Va.

R. J. Spitz, vice president of Newport Industries Co., div. of Heydon Chemical Corp., has been elected president of the Pulp Chemicals Association.



Cecil H. Chilton

American Association of Cost Engineers has named Cecil H. Chilton to receive its 1958 Award of Merit.

For Chemical Engineering, Chilton holds the post of Editor, Engineering Developments. He has been on the magazine's staff since 1950.

Cecil's interest in the field of cost estimating dates back many years. As a matter of fact, it was through this interest that he joined CE. He had already made a name for himself as an author in the field, and CE's Ted Olive was determined to get him to come and handle cost articles for CE on a full-time staff basis.

Since that time, his work as both writer and editor has been a big factor in CE's pre-eminence in the cost field.

Chilton is a director as well as a founding member of AACE.

- Harry W. Dietert, chairman of the board, Harry W. Dietert Co., Detroit, and a chemical engineer, has been elected president of the American Foundrymen's Society.
- G. W. Watts, formerly with Standard Oil Co. (Ind.) and L. C. Borroughs, of Shell Oil Co., have received certificates of appreciation from the American Petroleum Institute.
- Oliver W. Koester has been appointed manager of Lever Brothers Co.'s Hammond, Ind., plant and distribution center.
- Everett E. Klicker has been named market research manager of Michigan Chemical Corp., St. Louis, Mich.
- E. James Wilson has joined the technical services department of Monsanto Chemical Co.'s organic chemicals division.
- Wm. Jefferson and Wm. Watson, both of General Latex & Chemical Corp. have been promoted to these posts, respectively: assistant to the president; general manager of the Ashland, Ohio, plant.



Thomas M. Ware

The board of directors of International Minerals & Chemical Corp. has elected Thomas M. Ware president.

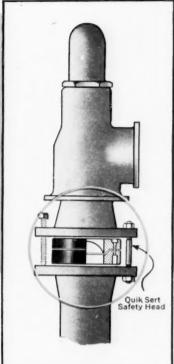
At 39, the former administrative vice president is the fifth and youngest president. He succeeds his father, Louis Ware, who was elected chairman of the board and chief executive officer.

Ware earned his chemical engineering degree at Cornell University. He served during World

You Can Prevent These Three Relief Valve Problems With a BS&B Quik-Sert







Leakage Corrosion "Freeze-ups"

The BS&B Quik-Sert Safety Head isolates the relief valve from the product under pressure. Mounted under the valve inlet, it is "bottle tight" until overpressure reaches the rated pressure of the preformed metal rupture disc.

The Quik-Sert Safety Head flange assembly is located inside the bolting of companion flanges. Easy insertion and removal is accomplished through the use of jack screws.

A BS&B Quik-Sert Safety Head Under the Relief Valve Gives You These Advantages

- Stops product loss at normal operating pressures
- Assures proper valve function at set pressure
- Lowers maintenance costs
- Reduces shutdown time

BS&B engineers will be glad to evaluate your pressure system for proper applications of the Quik-Sert Safety Head,



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BLACK, SIVALLS &

Safety Head Division, Dept. 2-N6 7500 East 12th Street, Kansas City 26, Missouri Telephone: BEnton 1-7200





SCREWED and SOCKET WELD STAINLESS STEEL FITTINGS





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SCREWED END FITTINGS

150# . . . All cylindrical fittings to 2" IPS inclusive are machined from solid forged and wrought materials. Higher sizes are machined from sound quality castings. Unions 11/4" IPS and over have octagonal ends.

2000#, 3000# and 6000# . . . Machined from solid drop forgings and are recommended for use where severe pressure-temperature conditions are encountered.

SOCKET WELD FITTINGS

2000#, 3000#, 4000# and 6000# . . . Machined from solid drop forgings and wrought materials and are recommended for use where severe pressure-temperature conditions prevail and permanent pipe connections are desired. Furnished with a wide reinforcing band extending beyond the depth of the socket.

CAMCO also manufactures a complete line of Flanges to MSS and ASA Standards.

One source for all your Stainless Steel Fitting Requirements.



NORTH HAVEN, CONNECTICUT

J. J. GATELEY 8283 Baldwin Street Oakland 21, California NAMES . . .

War II in the Navy's Office of Research. Before joining IMC in 1947, he worked briefly as a management consultant engineer.

Raymond J. Mucci has been appointed assistant to the general manager of Naugatuck Chemical division, U. S. Rubber Co.

James Day, of Dow Chemical Co., has been named general chairman of the annual meeting of the Drug, Chemical & Allied Trades Section of the New York Board of Trade.

Christian V. Holland, chemical engineer, has announced personal consultation services specializing in plastics, pharmaceuticals, and chemicals, in Riverside, Ill.

James A. Tong, president of Socony Mobil Oil Co. de Venezuela, has been awarded the University of Arizona's 1958 Alumni Achievement Award.

Clifford J. Rassweiler, vice president for research and development of the Johns-Manville Corp., will be awarded the honorary degree of doctor of science by Brooklyn Poly.

Dwight W. Kaufmann has been named manager of the Crucible Steel Co. of America's titanium and vacuum metals product division.

Charles O. Peyton has been appointed asistant general manager of Esso Standard Oil's new petroleum specialties department.

Quandt M. Adams has been named senior technical man at B. F. Goodrich Chemical's new glacial acrylic acid plant, in Calvert City. Ky.

Michael M. Dexter has been appointed to work with J. N. Pryor in Davison Chemical Division's technical service lab, developing uses for Davison's Syloid silicas,

Russell L. Haden, Jr., has resigned his post as vice

president and general manager of Virginia-Carolina Chemical Corp. to rejoin Dewey & Almy Chemical Corp. in a new executive capacity.

Howard M. Rodekohr has joined the process design section of Ethyl Corp.'s research and development department at Baton Rouge, La. Prior to joining Ethyl, Rodekohr was associated with C. F. Braun & Co.

Sig C. Schwartz, formerly in the byproducts development division of Portland Gas & Coke Co., has joined Charlton Laboratories as a consultant in chemical engineering.

A. S. Gregory, former manager of Weyerhaeuser Timber Co.'s central research department has been named director of research and development.

Donald C. Tretzel and D. G. Farquharson have been elected vice presidents of Kaiser Bauxite Co. wholly owned subsidiary of Kaiser Aluminum & Chemical Corp.

William P. Boyer, former director of research and development of Virginia-Carolina Chemical Corp., has been named head of the firm's chemical division.

OBITUARIES

Meno Lissauer, chairman of the Associated Metals & Minerals Corp., died May 27, after a brief illness. He was the chief factor in developing the firm from its modest beginnings in Cologne in 1903 to its present international status.

Jack Thorman, process control engineer with the Circle Wire and Cable Co., died May 26 of cancer. His age was 32.

John K. Hoskins, former assistant surgeon general and chief of the sanitary engineering division of the Public Health Service, died May 16.

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When One Will Do...



Better!

When *one* Roots-Connersville rotary gas meter is used in place of *two...* or *three...* or *four* of other types, metering costs go down.

This fact has been proved by utility companies and commercial and industrial users of gas everywhere as shown in this typical comparison:

Comparative Analysis	SPACE OCCUPIED	TOTAL CAPACITY	METER	COST	TOTAL
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DINE NO METER				1	

First cost is substantially reduced with the proper selection of the *one* Roots-Connersville meter, from the 39 sizes offered, for a specific requirement. Further savings are made in foundation, piping and installing costs, and in space.

But this is only part of the story. Roots-Connersville gas meters assure unalterable accuracy with far less maintenance than required by other types. There are no valves, valve gear or other small parts to wear out and cause inaccuracies. Servicing is limited to lubrication of bearings and gears and an occasional check of the operating differential.

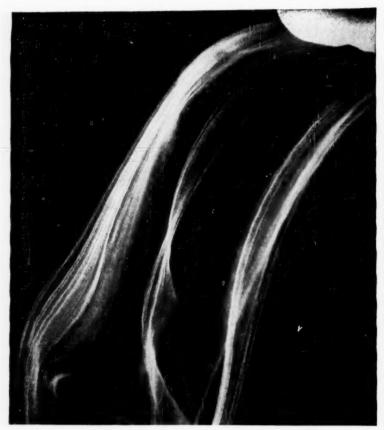
For additional data, please refer to our section in Chemical Engineering Catalog or Mechanical Catalog or write for descriptive Bulletin M-152.



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Chemicals

- Acetate, Isobutyl.....Here's how to use this versatile low-cost solvent in lacquer solvent systems. Also gives comparisons with other principal medium-boiling solvents.

 149A Eastman Chemical Products Inc.
- Alcohol, Allyl.....Reactions and uses of allyl alcohol, highly reactive unsaturated alcohol used as an intermediate in resin production, are described in new bulletin.

 149B Dow Chemical Co.
- Ammonia, Anhydrous....Bulletin on commercial and refrigeration grades of anhydrous ammonia gives data on physical-chemical properties, spees, Sun's service facilities. 149C Sun Oil Co.
- Antifoams.....Bulletin HSP-905 gives data on C-1 (light colored, water-soluble liquid) and HP (dry brown powder—used to control foaming and carryover in steam boilers.

Hagan Chemicals & Controls Inc.

- Antifoams, Coating.....Information sheet on two new coating antifoams, PV-45B and PV-48B which have application in the paint, adhesive, pulp and paper industries.

 149E Hodag Chemical Corp.
- Butadiene, Styrene Rubbers.....How to select an oil for compounding and extending butadiene-styrene polymers, organized in a convenient classification system.
- Celanese BPL....beta Propiolactone now available in commercial quantities as a starting material in the synthesis of new products. Samples & Bulletin #N-61 available. *Celanese Corporation of America 79
- Cyanide, Chromium Wastes.....Details on a low-cost system for disposing of cyanide and chromium wastes is now available in a 6 p. bulletin (# 90-242-13). 1496 Fischer & Porter Co.
- Diethylene Glycol Dimethyl Ether....
 Entrance of Olin Mathieson into
 this field is marked by a new technical bulletin. Product will be
 marketed as Poly-Solv D2M.
 Olin Mathieson Chemical Corp.
 - * From advertisement, this issue

- Epoxy Compounds.....A complete family of HYSOL 6040 epoxy compounds is now available. Data Bulletin includes chart of 3 resins showing properties when used with hardeners. 1491 Houghton Laboratories, Inc.
- Essential Oils.....36 p. price list and catalog of essential oils, aromatic chemicals, flavor and perfume bases, dry soluble seasonings is up to data as of April 1, 1958.

149J Dodge & Olcott.

- Graphite, Colloidal.....Here are answers to many technical questions asked about colloids with story, drawings, pictures—published as "The ABCs of Colloidal Dispersions."

 149K Acheson Colloids Co.
- Methyl Chloride.....One of a series on industrial chemicals, this bulletin gives physical and chemical properties, specifications, toxicity and uses of methyl chloride. 149L Ansul Chemical Co.
- Nuclear Products.....Products, facilities and engineering and design services of Superior Tube Co.'s nuclear products division are illustrated in Data Memo. No. 23. 149M Superior Tube Co.
- Organic Chemicals.....More than a dozen organic chemicals are outlined along with shipping information, sales office addresses, and commercial applications. 149N

Olin Mathieson Chemical Corp.

Polyethlene Mixture Properties.....

The mixing of proportions of pellets of high and low-pressure polyethylene is growing. Here's how to find preferable proportion fast.

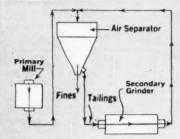
1490 Plastics Div., Koppers Co.

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- Rare Earths.....Abstracts of a comprehensive survey covering ten years of literature on metallurgical applications of rare earths are now in a 46 p. publication. 150A Davison Chemical Co.
- Resins, Epoxy.....Comprehensive survey of the uses and advantages of epoxy compounds in the chemical process and other industries appears in 8 p. brochure.

 150B Marblette Corp.
- Solvents.....where odor is a problem use Sol 71 & 72 for polishes & cleaners, Sol 360 for fast evaporation & Sol 140 for high-flash. Bulletin.

 *Shell Oil Co.
- Wetting Agent....Sole-Terge S-2-S is an anion-active wetter-penetrant compatible with alkali, acid or salt systems. Useful at low percentage levels. Bulletin 338-1.

 150C Sole Chemical Corp.
- Zireonium, Hafnium.....16 p. brochure reviews production of zirconium from raw materials & properties of zirconium and hafnium in nuclear reactor applications. 20 *Mallory-Sharon Metals Corp.

Construction Materials

- Alloys.....Use of welded hard-faced alloys to increase service life of critical surfaces in sleeve-type bearings is described in new data sheet. Send for your copy.

 150D Cleveland Hard Facing.
- Castings, Stainless......Comparison data, tables and photographs present the methods and procedures used to obtain castings with strengths 20% higher than code. 150E

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 88 *Metal & Thermit Corp.
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 150G F. D. Farnam Co.
- Glass Fabrication.....Catalog 80-23, "New Precision in Glass Fabricating," discusses fabrication, materials, tolerances and applications of precision glass products. 150H Fischer & Porter Co.

- Insulations....Foamglas is acid-proof, water-proof & vapor-proof because it is made entirely of glass. Its dimensionally stable, can't burn, & unusually strong.

 26 *Pittsburgh Corning Corp.
- Insulation, Magnesia....Tables give simplified methods for selecting proper thicknesses for pipe coverings in both single and double-layer. Catalog 12C

 1501 Ehret Magnesia Mfg Co
- Linings, Tank.....Brochure describes three types of polyvinyl chloride tank linings. Technical service staff and laboratory are available to assist you in design. 150J Kaykor Industries, Inc.
- Metals Production and processing of made-to-order metals in experimental and production quantities is described in an 8-page booklet. Write for your copy.

 150K Hamilton Watch Co.
- Metal Fabrications Catalog covers manufacturers line of tanks, housings panelboards, weldments, bases, power plants, machine pans and guards. 150L Littleford Bros., Inc.
- O-Rings....New high-precision tetrafluoroethylene O-rings, designed for extreme temperatures, pressure and highly corrosive applications, meet AN and MIL specs. Bul. TR2772. 150M Tri-Point Plastics, Inc.
- Packing, Column Made of embossed wire cloth, trimmed into fiat conical discs. Bulletin gives the inside story on Stedman packing, its characteristics & test results. 150N Packed Column Corporation.
- Paint, Acrylic..... A 30-page technical manual outlines the technology of acrylic latex paints for interior use. It's based on five years formulating experience. 150Q Rohm & Haas Co.
- Plastics....."New Shapes in Plastics." a colorful brochure, shows versatility of products made by vacuum, vacuum snap-back, drape and stretch forming.

 Delta Products
- Silicone Systems.....Use of silicone dielectrics in the insulation systems of motors and transformers achieves reliability and standards. Code 10-106

 1500 Dow Corning Corp.
- Soaps, Metalic Use of metalic soaps for molding plastics is reviewed in technical data report. Zinc and calcium stearates for high-speed molding.

 150R Metasap Chemical Co.
- Teflon, Cementable....Glass-supported, unsupported and metal-clad cementable Teflon bonds well to almost any surface. Retains Teflon's mechanical properties.

 1508 Continental-Diamond Fibre
- Welding, Titanium.....Technical brochure discusses the method and techniques used in arc welding titanium. Lists weldable grades of titanium, preparations. 150T Mallory-Sharon Metals
- Wire, Welding.....Pocket Guide contains technical information on chemical composition, mechanical properties and operating procedures for each wire. Form ADC 873.

 150U Air Reduction Sales Co.

Electrical & Mechanical

- Couplings, Motor....Folder 2875 detals pertinent application and selection data for new MC couplings. Coupling sleeve is of one-piece design.

 Link-Belt Co.
- Electrical Equipment New 12-page pictorial bulletin emphasizes the variety of equipment available in condulet, floodlight, aviation and traffic-control product lines.

 150W Crouse-Hinds Co.
- Couplings, Fluid Drives.....Compact, economic drives and couplings, identified as 5D and 5C, are additions to line of Flexidyne dry fluid drives and couplings. 150X Dodge Mfg. Corp.
- Engines, Gas..... A series of three new fliers describes in detail a line of 4-cycle, V-angle gas engines designed for supplying industrial power. To 1.760 hp. 150Y
- Mechanical Parts.....Reference book MMES-P covers molded, extruded and die-cut parts--rubber, synthetic, plastic. Lists all types, dimensions, durometers of grommets. 1502 Miller Products Co.
- Switches, Transfer How to select an automatic transfer switch, and applications of this equipment are covered in a new booklet. Discusses inrush capacity. Pub. 596R1. 150BB Automatic Switch Co.
- Turbines.....Exclusive pilot operated excess speed safety trip supplementing constant speed governor; choice of metallic or carbon ring backing assemblies. Bulletin 135.

 29 *Coppus Engineering Corp
- Turbines, Steam.....A complete line of turbines for all applications and operating conditions from 5 to 2,000 hp. Solid-wheel, single-stage axial flow, or multistage.

 150CC The Terry Steam Turbine Co.

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- Materials Handling....."7 Ways to Cut Costs" explains how material handling methods are developed through versatility of Payloader through versative, tractor-shovels. *Frank G. Hough Co
- that Hardware.....For use on pallets. Permits users to make portable racks with standard pallets, quickly, easily and at low cost. 4 models featured in literature. Paltier Corp
- Scale, Bagging Automatic machine accurately obtains the net weight of almost all materials packaged in open-mouth paper or textile bags. Bulletin 3749B.

 154D Richardson Scale Co.
- Slings, Woven Wire.....Gripper slings of smooth, spiral wires join to-gether across sling body. Can reduce load damage in production or shipping; are safer for operator. 154E Cambridge Wire Cloth Co.
- Storage Units, Bulk.....Glassed-steel tanks for field bulk storage are offered for a broad variety of free-flowing, semifree-flowing and fious materials. 154F A. O. Smith Corp
- apping Tool.....Fully powered combination steel strapping tool applies each strap with the same predetermined tension by means of a throttle on the handle. Strapping Acme Steel Co.
- Tanks, Plastic Series of data sheets describe advantages of corrosion-resistant plastic tanks, vents, ducts, hods, pipes, fittings and pilot-plant equipment.

 154H Carl N. Beetle Plastics Corp.
- Trucks, Pneumatic-Tired A 12-page booklet discusses three im-portant points to consider in lift truck purchasing. Lists 36 items of optional equipment. Hyster Co
- Trucks, Fork.... Catalog covers com-pany's series of lift trucks, telling the engineering, design, construc-tion and operation of the units. BU-451 154J Allis-Chalmers Mfg. Co.
- ick, Fork.... New battery-operated fork truck of 2,000 lb. capacity features accessibility and easy maintenance. Photos and drawings illustrate the 6-page bulletin.

 Clark Ford. Truck. Fork

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154L Superior Combussion Ind

Coils, Heating & Cooling.....Better because of air activating guides & more prime surface than any other coil. New Application Manual with complete data, yours on request. 81 "Westinghouse Electric Corp.

s, Water.....For complete drainability, easy cleaning, & high heat transfer get the inside information by specifying descriptive Bulletin Coils, Water. #R-50. *Aerofin Corp.

- Coolers, Steam-Jet.....Water is the only refrigerating agent used. No hazardous gases, no high pressure vessels needed. Send for Bulletin #9143-B for the complete story. *Ingersoll-Rand
- Heat Exchanger.....Fin-Pak, a new and compact heat exchanger, operates with low pressure drops under high differentials for gas to gas, or gas or air to liquids. The Air Preheater Corp
- Heat Exchangers A new, highly flexible, fully standarized line of heat exchangers are readily assembled to handle any combination of liquids and gases. American-Standard 154N
- Haters-Coolers Bulletin 130 on air engineering for process industries describes after-coolers air condi-tioners, liquid coolers, heat ex-changers & condensers. *Niagara Blower Co.
- Heating Cartridges.....A new 12-page catalog describes a complete line of precision cartridge heating units and ceramic heating units. Firm offers full range of sizes 1540 Hotwatt, Inc.
- Thermocouples, Furnace Tube Wall....
 Cut installation time by 50%, meesure increases in outer tube wall temperature when coking causes a heat loss in inner wall. Bul. EDS45.

 Thermo Electric
- wers, Cooling....Air-conditioning units feature slip-fit joints and just one grease point, greatly simplifying maintenance work. No-warp, nailless filling.

 154P Mason Products, Inc. Towers,
- vers, Cooling.....Induced draft, counter flow cooling towers are described in 14 p. Bulletin 4,9.080A. Covers typical cross sections, framework, basins, filling, etc.

 154Q J. F. Pritchard & Co.
- Towers, Packedeliminate move-ment in a packed bed with a float-ing "hold down" plate made to fit any size tower in a variety of any size tower in a variety of weights. Bulletin HDP-56.

 *U. S. Stoneware

Instruments & Controls

- Oxygen... Analyzer. ... Analyzes of continuously records minute quantities of oxygen dissolved in feed-water for steam generating plants. Bul. 148 Cambridge Instrument Co.
- Annunciator. ... New static-magnetic annunciator monitors complex au-tomatic machine and continuous process operations. gree of reliability. 1548 Have high de-Panellit, Inc.

- Cascade Systems.....New Transcope Plug-in Recorder provides a com-plete cascade system . . in half the plete cascade system . . in half the space required by other systems. Request Bulletin 962861. 84 "Taylor Instrument Cos.
- Chromatograph....Advanced research instrument for analysis by gas and vapor chromatography readily han-dles samples boiling up to 475 C. Bul. 837

Burrell Corp

- .LimiTorque con-Control Systems trol Systems....LimiTorque con-verts any variable into a constant. Complete process control system achieved with this modern all elec-tric actuator system. Bulletin 6-57. Philadelphia Gear Corp.
- Controller, Temperature....Pyrometer controller, which can be applied wherever a thermocouple is useful. has a compact size for panel mounting efficiency.

 Bul. 3885.

 Illinois Testing Lab.
- trols, Motor Semi-conductor variable motor controls designated as MRS (motor rectifier single) series use d. c. motors operating from a. c. power sources. Carpco Mfg 154V
- trols, Temperature New catalog furnishes specifications & data on a variety of general-purpose, dual-switch, & explosion-proof Controls, Temperature. dual-switch, & explosion-proof temperature controls. Cat. 400. 154W United Electronic Controls
- trols, Valve.....Design manual gives complete design information on flexible shaft valve controls in-cluding valve couplings and remote Controls, Valve operating terminals. Stow Mfg. Co.
- Gauges, Liquid Level.....Drop Forged Steel Automatic Gauges step up safety performance & service life. See Catalog F-9 for complete data on guage cocks, glasses & trims. 121 *Henry Vogt Machine Co.
- for either steam or motor-driven pumps, can be used for excess-pressure service in boiler feeding. educing-valve service. Copes-Vulcan Co.
- Indicator, Digital.....The Precision In-Line Digital Indicator accepts a variable-frequency a. c. input, and converts it to a 5-digit indica-tion: Cat. 51-1800. 154Z Fischer & Porter Co.
- Indicators, Flow.....Bulletin 18W describes three models of flow indicators—flapper, rotary (paddle wheel) and ball. Maximum pressures to 250 psig., temperatures to 500 F. 154AA Schutte and Koerting Co.
- Indicators, Gas.....Booklet gives the complete story of methods of selecting instruments and testing procedures to keep instruments operating smoothly. 154BB Davis Emergency Equip. Co.
- Instrumentation Technical Bulletin 90-135-25. "Instrumentation of Water and Waste Treatment in Pulp and Paper Mills." shows how instrumentation ups efficiency.

 154CC Fischer & Porter Co.
- Instrumentation, Environmental Instruments measure, record, program and control temperature, midity, pressure, flow, and other variables. Bul. W1831. The Bristol Co. 154DD

^{*} From advertisement, this issue

- Manometers.....precision ancroid and dial type manameters used as calibrators of pressure transducers. Pressure ranges: 31.5 in. Hg absolute to 150 in. Hg absolute. 155A Wallace & Tiernan Inc.
- Meters, Gas.....One of our meters often replaces two or three of other types thus cutting costs. Assure unalterable accuracy. For details, request Bulletin M-152.

 147 *Roots-Connersville Blower
- Meters, Liquid Ask for helpful metering Bulletin 566-B for the details on Neptune Liquid Meters. Stop costly down-the-drain losses with quality control meters. 156 "Neptune Meter Co.
- Photofluorometer....Electronic Model
 12c is described in Bulletin B-245.
 Unit is used for accurate measurement of compounds measurable by
 fluorescence.
 155B Coleman Instruments Co.
- Photometer, Flame.....Designed for the rapid, precise determination of sodium, potassium and calcium, the Model 21 photometer offers speed, ease of operation. Bulletin B-242. 155C Coleman Instruments, Inc.
- Reader, Punch Card....Data Sheet 5705 describes PCR control (punched card reader) for automatic control of blending, batching and proportioning operations. 1550 Richardson Scale Co.
- Recorders.....On a single chart you can measure four variables with a Bailey receiver recorder. Interchangeable receivers permit new combinations. Booklet E12-5.

 86 *Bailey Meter Co.
- Rectifier Equipment....custom engineered rectification in Semiconductor Power Conversion Equipment & Systems. Flexible designs to meet specific needs. "Guide".

 155E Sel-Rex Corp.
- Rectifiers.....Excitron mercury are rectifiers come in sealed or pumped tubes in open or enclosed construction, with an internal cooling system. Bul. 12B8494.

 89 *Allis-Chalmers Mfg. Co.
- Regulators, Voltage The complete standard line of IE automatic voltage regulators are all electronic with no moving parts. They feature instantaneous correction.

 155F Superior Electric Co.
- Rotameters.....Bulletin 130 describes armored AR-MET rotameters designed for pressures to 5,000 psi. and for flow rate equivalents up to 3,000 gpm. of water.

 155G Brooks Rotameter Co.
- Separators. Air.....lower power costs up to 50% by using air separators in closed-circuit grinding systems. Precise classification. For information request Bulletin #087. 149 *Sturtevant Mill Co.
- Stethoscope Airsonic stethoscope is important to all those interested in the design and use of equipment which may or may not make a sound in operation.

 155H M. Paquet & Co.
- Tachometers....Bulletin 795 describes Model "J" stationary tachometers for permanent mounting on machines. Units are mechanical centrifugal type, 4-in. dial size.

 1851 Herman H. Sticht Co.

Use UE Explosion Proof PRESSURE-VACUUM CONTROLS





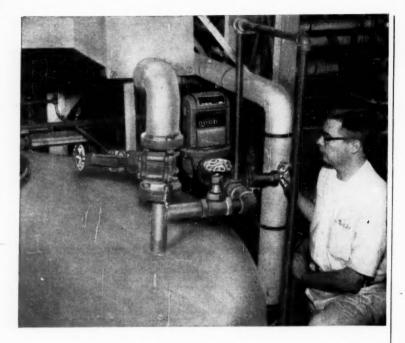
The Types J95 and J96 Pressure-Vacuum Controls are designed for applications in hazardous locations where explosive vapors or gases are present and close on-off differential control is required. In both units, pressure settings are uncalibrated and adjustment is made by an internal nut.

Adjustable Range	. J95 — Various ranges between 0 and 500 psi limits.
	J96 — Various ranges between 0 and 180 psi limits.
Switch Differential	. J95 — Factory pre-set for any differential between 2 and 30 psi.
	J96 — Factory pre-set for any differential between 3" W.C. and 2 psi.
Switch Ratings	. Up to 15 amps. at 115 or 230 volts A.C. 20 amp. A.C. or D.C. swtiches also available.
Switch Types	N.O., N.C., or Double Throw — no neutral position.
Maximum Pressure .	. J95 — Up to 600 psi.
	J96 — Up to 180 psi.
Electrical Connections	. J95 — Lead wires attached to screw type terminals on switch via ½" NPT opening.
	J96 — Lead wires attached to terminal block via $34'''$ NPT opening.
Pressure Connection .	Via a ½" female NPT connection.
Enclosure	J95 — Cast iron with a gray, baked-enamel finish. For use in Class I, Groups C and D locations.
	J96 — Cast iron base and aluminum cover. For use in Class I, Group D; Class II, Groups E, F, and G; or Class III locations.
Mounting	Surface-mounted by four corner holes with clearance for 1/4" screws.

UNITED ELECTRIC manufactures a complete line of temperature, pressure, and vacuum controls. For information on modifying standard units or providing custom-built units, consult a UE application engineer. For additional data on the Types 195 and 196, request new literature available.



[•] From advertisement, this issue



Stop costly giveaways... Stop down-the-drain losses with

NEPTUNE liquid METERS



IN ICE CREAM TOO - this ice cream plant gets taste-control by metering to make sure exactly the right amount of corn syrup goes into the mix. Operator simply presses buttons on the Neptune Auto-Stop to set the amount of corn syrup to be delivered . . . opens the valve . . . and the meter shuts off automati-Ticket printing meters also available.

Sizes from 5/8" to 6", 2 to 1000 gpm. for handling over 150 liquids.

Get built-in cost control with Neptune meters . . . like this Stein-Hall plant making liquid adhesives. They always know how much water and vinyl acetate is used ... and, hence, how much their product costs. The meter doesn't forget, doesn't get tired and doesn't mis-count.

Besides controlling costs with their Neptune meters Stein-Hall now gets consistent quality control of each batch of adhesive. No

more rejected

batches.

Ask for helpful Metering Bulletin 566-B





19 West 50th Street, New York 20, N. Y.

Branches ATLANTA . BOSTON . CHICAGO DALLAS . DENVER . LOS ANGELES in: LOUISVILLE . No. KANSAS CITY, Mo. . PHILADELPHIA . PORTLAND, ORE. SAN FRANCISCO (Millbrae) . IN CANADA: TORONTO 14, ONT. LITERATURE . . .

Chamber.....A new 27-cu. ft. altitude, humidity and temperature Test Chamber. test chamber is available with vari-ous test ranges, cabinet sizes and accessorie

Environmental Equip. Co.

Titrator, Continuous.....Using con-trolled-volume pumps for metering both sample and standard solution, the Dow-Hart titrator couples with control instrumentation Milton Roy Co.

Transmitter, Turbidity..... Electri-cally transmits measurements of relative smoke density or turbidity to recording or indicating equip-Bailey Meter Co.

Pipe, Fittings, Valves

Connectors, Flexible Bronze con-nectors simplify misaligned hook-ups and provide flexibility that pro-vides for expansion or vibration. Bul. UC3 Universal Metal Hose Co.

Fittings, ings, Flanges.....Bulletin de-scribes how users of welding fittings and forged steel flanges can save time and money with close dimen-sional products.

Babcock & Wilcox Co.

nges Write for handy 36-page reference booklet containing useful data on flanges in forged steel or special models in carbon or alloy 42 *Phoenix Mfg. Co.

nts.....provide safe easy handling of liquid missile fuels. Stainless ex-pansion joints for use in nuclear, missile & industrial applications. Catalog. *Solar Aircraft Co.

ves.....for acid service, made of alloy stainless. No corrosive fluid processor can afford to overlook the "Craneloy 20". Request Circular AD-2080 for the facts. *Crane Co.

ves Circular 607 describes the new engineering features and per-formance of two types of forged steel gate valves. Valves ideal for high-pressure, temperature. Valves Lunkenheimer Co.

Valves.....Non-lubricated, full open-ing, low pressure drop and positive tightness are features of Okadee valves. Come in 3 operating mechanisms. Bulletin 1256. Okadee Co.

Valves, Bronze Globe....Install this plug type Valve, made for maximum wear in valve-killing service in close-control steam service or where abrasion is a problem. #202-A. 25 *Jenkins Bros.

Valves, Float....Catalog sheet de-scribes auxiliary-actuated float valves which permit control of liquid levels within 1-in. limits in open or closed vessels. 156H Atlas Valve Co.

Valves, Glassed ... New flush valve has one-piece glassed head and stem Teflon-glass fiber seat. Ball-joint construction gives leakproof sealing. Data sheet 42.

*Pfaudler Co.

* From advertisement, this issue

- Valves, Globe.....Forged-steel valves come in ¼ to 2-in. sizes Bulletin DH-213 lists material and dimension specifications, pressure-temperature ratings. 157A American Chain & Cable Co.
- Valves, High-Pressure.....Standard line of control valves is now available in sizes ranging from 1 to 14 in., with pressure ratings up to 2,500 psi.

 Conoflow Corp.
- Valves, High-Vacuum ... Right-angle, poppet-type, high-vacuum valves have a quick-acting air cylinder and a full-opening design for the micron range. DS-570.

 157C F. J. Stokes Corp.
- Valves, Plug.....For positive control at high temperatures, cut high maintenance cost by requesting complete catalog information on Wedgeplugs, non-lubricated valves. 41 "Wedgeplug Valve Co.
- Valves, Pump.....You want maximum valve dependability for your reciprocating pumps & Durabla gives you just that in the new V-7 unit. 8-page bulletin CE-68 on request. 134 °Durabla Mfg. Co.
- Valves, Relief....Bulletin 5200-A describes features of multiple-disc relief valves for steam systems. Specifications for vertical, horizontal and angle styles. 1570 Cochrane Corp.
- Valves, Safety-Relief.... Detailed information for selection and sizing of nozzle safety-relief valves applicable to process piping is presented in catalog.

 157E Farris Engineering Corp.

Process Equipment

- Accumulators The different applications, sizes and types of hydropneumatic bladder-type accumulators are described in a 6-page brochure. Broch. PR200.

 157F Greer Hydraulics, Inc.
- Blendors.....for consistently uniform blends, & dust-free, moisture-proof operation. Write for Bulletin 15a-1 for lab information & Bulletin 15 for production use. 46 *Patterson-Kelley Co.
- Classifier, Wet.... New classifier has belt, with lifting flights attached beneath; moves upwardly out of the sand bed; creates the effect of moving washing compartments.

 157G Hardinge Co., Inc.
- Crushers....Bulletin 6105 is devoted to Type H jaw crushers; Bulletin 6637 is concerned with crushing rolls. Both of interest to the mining and processing industries. 157H Traylor Eng. & Mfg. Co
- Digester-Mixer Gas-lifter digester circulator-mixer increases efficiency through complete circulation and contact of digester contents. Bulletin 25-S-91.

 1571 Walker Process Equipment.
- Dehydration Bulletin presents in text and graph form the latest information on air and gas dehydration with silica gel. Covers natural gas dehydration.

157J Davison Chemical Co.

Cramo Thermocouples For Furnace Tube Walls

Cut Installation Time 75%

Inscallation time, always a high-cost factor with furnace tube wall thermocouples, has now been reduced up to 75% by Thermo Electric. Responsible for this reduction is T-E's "Ceramo" construction—ceramic-insulated conductors with overall metal sheathing. Conventional, rigid assemblies were both costly and difficult to install. "Ceramo" furnace tube wall thermocouples virtually eliminate these difficulties.

Applications

These thermocouples measure the increase in outer tube wall temperature when coking or scaling of the inner wall causes a loss of heat transmission. They are used on furnace tubes, superheaters, pre-heaters, and for determination of start-up temperatures.

Advantages

"Ceramo" furnace tube wall thermocouples can be bent to almost any shape—greatly simplifying difficult installation around tubes.

Large holes in the furnace wall, previously required to accommodate the motion of old-style, rigid assemblies, are no longer necessary. "Ceramo," though basically rigid, will flex with the differential motion between tubes and furnace wall. "Hot spots," resulting from faulty insulation around large, rigid assemblies, are also eliminated. Since "Ceramo" measuring junctions are completely enclosed, they need only be tack welded to the tube wall. There's no need to seal-weld the entire outer end of conventional, open-end protection tubes. "Ceramo" is generally used without protection tubes.

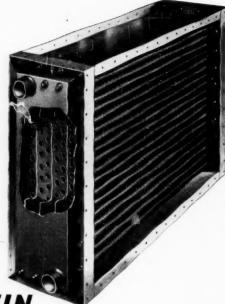
"Ceramo" construction provides extremely small O.D.'s—ranging from 1/16" to 7/16".

Write For Bulletin EDS-45-E

Thermo
Electric co., INC.

in Canada: THERMO ELECTRIC (Canada) LTD., Brampton, Ont.

^{*} From advertisement, this issue



AE DF

Removable-Header WATER COILS

- Complete Drainability
- Easily Cleaned
- High Heat Transfer

Completely drainable and easily cleaned, Aerofin Type "R" coils are specially designed for installations where frequent mechanical cleaning of the inside of the tubes is required.

The use of 5%" O.D. tubes permits the coil to drain completely through the water and drain connections and, in installations where sediment is a problem, the coil can be pitched in either direction. The simple removal of a single gasketed plate at each end of the coil exposes every tube, and makes thorough cleaning possible from either end.

The finned tubes are staggered in the direction of air flow, resulting in maximum heat transfer. Casings are standardized for easy installation.

Write for Bulletin No. R-50

AEROFIN CORPORATION

101 Greenway Ave., Syracuse 3, N.Y.

Aerofin is sold only by manufacturers of fan system apparatus. List on request.

- Dehydration Unit.....New line, ranging from 2 to 8 in. dia., make it possible to obtain, economically, dew points of -150 F. for costs of 7 cents per lb. of water.

 158A Dehydrators, Inc.
- Disk, Rupture the perfect disk accurate to ±5% of rated burst, mount in standard flanges, corrosion resistant. Information on these features in Bulletin #315-1
 140 *Palls Industries
- Dust Collectors.....Self-cleaning 18"
 cyclone tube solves problems of
 dust collection. Greater capacity
 with less air flow resistance. Bul.
 D-584.
 B160 °Dustex Corp.
- Dust Collector.....Revised edition of 12-page bulletin describes and illustrates a wet-type dust collector. No sprays, moving elements, water eliminators.

 158B Dust Suppression & Eng.
- Dust Control....Bulletin No. 270A2 describes the operation and application of dust control equipment in asphalt plants. Photographs illustrate.

 American Air Filter Co.
- Equipment, Rubber & Plastic fittings, valves, & linings in highimpact, rubber-plastic ... economical & insensitive to corrosives. For information specify bul. from ad. 132 *American Hard Rubber Co.
- Filter, Gas....removes all fine dust & scale from gas removable filter material in treated curled hair or spun glass wool. Minimum pressure loss at filter. Bulletin 9200.

 158D Norwalk Valve Co.
- Filter Presses Company's filter presses are available in designs and capacities to handle any filterable mixture and any filter material. Catalog.

 141 *D. R. Sperry & Co.
- Filters, valveless....in same price range as manual filters, but completely automatic. Our new bulletin tells how you can cut both initial & operating costs.

 43

 *Permutit Co.
- Gas Spearation Plants....Bulletin describes typical applications for extremely low-temperature liquefaction of gases and their separation by distillation. 158E American Air Liquide
- Ion Exchanger.....The Higgins Contactor, a practical, continuous-countercurrent unit for ion exchange can be a useful tool for production, pilot-plant work.

 158F Chemical Separations Corp.
- Kilns, Rotary.....write for bulletin #1115 for complete information on the only kiln that is designed to reflect quality. craftsmanship & rugged dependability.

 16 *Traylor Engineering & Mfg.
- Mill, Hammer..... Description of a new heavy-duty hammer mill series includes design, construction and application information. Schematic drawing. Bulletin 1-C.

 Sprout, Waldron & Co.
- Mills, Roller.....Raymond super roller mills satisfy the maximum demands of industry for huge tonnages of high fineness materials. Available in several sizes. Catalogs.

 96 °Combustion Engineering, Inc.

^{*} From advertisement, this issue

- is, Roller.....get all the facts outlined in our new catalog on the roller mill designed for quality fine grinding . . 20 Mesh to 400 mesh. Exclusive gearless & pinion drives.

 *Williams Patent Crusher
- ...the Turbulizer is a high speed, continuous mixer designed to provide disintegration & blending of dry materials, or pastes involving liquids. Color Bulletin. 77 *Strong-Scott Mfg. Co.
- Screen Changer.....Bulletin HW 458 introduces an exclusive device for changing hammer mill screens instantly from the floor above. For all Series 10 mills.

 159A Schutte Pulverizer Co., Inc.
- Wire Cloth.... Free 94-page catalog and stock list tells full range of wire cloth available, describes fabrica-tion facilities and gives metallurgical data. *Cambridge Wire Cloth Co.

Pumps, Blowers, Compressors

- Blowers and Exhausters.....Six-page bulletin gives operator data, specifications and performance curves for expanded line blowers and exhausters. Bul. 581.

 158B Miehle-Dexter Div.
- Compressors. ...Illustrated 40-page catalog discusses a complete line of compressors and gas turbines, highlighting latest engineering and perormance data. Clark Bros. Co.
- Compressors, Centrifugal . . . Rugged De Laval centrifugal compressors per-form dependably in heavy-duty continuous operation. Bulletin 0504 is available on request.
 - *De Laval Steam Turbine Co.
- Compressor, Rotary Ask for new bulletin AC0100.1 giving typical per-formance data on the axial-flow unit that combines advantages of eciprocating & centrifugal models.

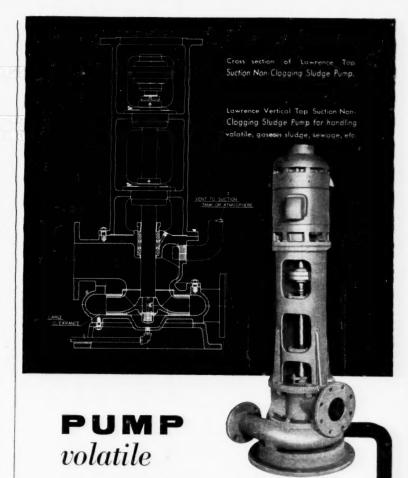
 1 *Fairbanks-Morse Co.
- Fans, Rubber-Lined.....Rubber-lined fans have up to twelve times the life of ordinary metal fans in severe corrosive fume service. Bul. 2424-F. 28 "Buffalo Forge Co.
- np....A new pump-motor unit for original equipment requiring circu-lation of corrosives and for pilot-plant and laboratory uses is designed to 16 gpm.

 158D Goulds Pumps, Inc.
- Pumps, Chemical... Two-fisted per-formance—top ability to resist cor-rosion & top ability to move liquids economically & efficiently. Ask for Bulletin B-1b. *La Bour Co.
- Pumps, Screw.....Abrasive quality of insulating paints is overcome by this new model. Completely resistant. For details on external screw pumps, send for Bulletin S-206.

 136 *Warren Pumps, Inc.
- Pumps, Stainless Steel.. Heavy-duty units have new design features for efficient, dependable operation for pumping all kinds of corrosive materials. 158F

Ladish Co.

* From advertisement, this issue



SLUDGES AND SLURRIES

...without clogging

...under a low net positive suction head (NPSH)

... without gas or vapor binding

The Lawrence Non-Clogging Top Suction Pump is designed specifically to handle volatile sludges and slurries. Large clearances through the impeller and casing completely prevent clogging. Volatile gases or vapors liberated at the impeller entrance (the point of lowest pressure), are pushed up and out of the way and can be vented back to the suction tank or exhausted to atmosphere.

This type of pump can operate with a very low Net Positive Suction Head (NPSH) and never become gas or vapor bound. It is made in all metals and alloys such as: — cast iron, bronze, stainless steel, Hasteloy, etc. — depending on the material pumped.

For further details on Lawrence Non-Clogging Slurry and Sludge Pumps write for Bulletin 206-4.





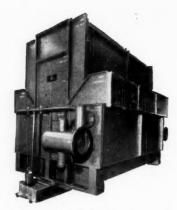
357 Market Street, Lawrence, Mass.



CONOMICAL COOLING OF GASES AND COMPRESSED AIR

Cooling gases or cooling and removing moisture from compressed air, the Niagara Aero After Cooler offers the most economical and trustworthy method. Cooling by evaporation in a closed system, it brings the gas or compressed air to a point below the ambient temperature, effectively preventing further condensation of moisture in the air lines. It is a self-contained system, independent of any large cooling water supply, solving the problems of water supply and disposal.

Cooling-water savings and powercost savings in operation return your



equipment costs in less than two years. New sectional design reduces the first cost, saves you much money in freight, installation labor and upkeep. Niagara Aero After Cooler systems have proven most successful in large plant power and process installations and in air and gas liquefaction applications.

Write for Descriptive Bulletin 130.

NIAGARA BLOWER COMPANY

Dept. CE-6, 405 Lexington Ave., New York 17, N.Y.

Niagara District Engineers in Principal Cities of U.S. and Canada

self-cleaning 18" cyclone tube solves major problems of dust collect Important savings in installation cost . . . negligible maintenance ... uninterrupted performance ... with all these the longer, larger cast tube originated by DUSTEX assures the following advantages: Greater capacity with less air flow resistance Abrasion resistance of precision cast white iron alloy Completely self-cleaning action Ability to handle inherently sticky materials Higher efficiency with reduced pressure loss WIDELY PROVEN. Recovers dry chemical and pharmaceutical dusts, cement, limestone, slag and silica dusts, and many other valuable materials. Write today for D-584 descriptive bulletin. P.O. BOX 2520, BUFFALO 25, N.Y.

LITERATURE . . .

Pump, Suction....designed specifically to handle volatile sludges & slurries, without clogging or gas or vapor binding. Write for Bulletin 206-4. 159 *Lawrence Pumps, Inc.

Services, Processes, Misc.

Chart.....Contains information on the relative corrosion resistance of 34 standard grades of stainless steel. Especially useful when selecting most suitable grades. 160A Peter A. Frasse & Co.

Conversion Table, Low-Temperature...

Handy, pocket-size table converts
deg. C. to deg. F. or deg. K. Temperature range covered varies from
absolute zero to 0 C.
160B Trans-Sonics, Inc.

Data Card.....Lists the maximum allowable working pressures. by tube size, for electric-resistance welded boiler tubing. Information based on latest ASME Boiler Code.

Babcock & Wilcox Co.

Fabricating Facilities.....New booklet pictorially describes the engineering services and facilities for designing, forming, joining and finishing aluminum products.

160D Aluminum Co. of America

Fire Extinguishing System..... Have 24-hour-a-day automatic fire protection with Kidde's fully automatic system. Pressurized, no falling weights. Write for Booklet I-19. 135 *Walter Kidde & Co., Inc.

Fire Protection Systems.....new 44page manual gives you a comprehensive picture of advanced methods for Special Hazard fire protection, with applications. 128 Grinnell Co.

Glossary A glossary of terms used in temperature and pressure measurement provides an up-to-date reference guide to terms frequently used in the field.

Trans-Sonics, Inc.

Safety Enclosure bulletin A-11 describes safety inclosure with modular construction that allows one or a combination of units to be used in any arrangement.

S. Blickman

Sewage Treatment Plant.....Bulletin 26-S-92 gives details on Sparjeraerobic process package sewage treatment plant, suited for installation of 100 to 2,000 pop. equiv. 160G Walker Process Equipment.

Udex Process..... Economics of Udex process for solvent extraction of BTX cuts is summarized in booklet form. Data includes yields, utilities, operating cost.

160H Universal Oil Products Co.

Waste disposal systems....the new Dumpmaster self-loading packer cuts waste disposal costs by twothirds in chemical processing plants. Free 40-page bulletin. 73

Water Treatment Products....Complete line of Calgon water treatment products for evaporative condensers, cooling tower systems is announced in instruction folder.

1601 Calgon Co.

^{*} From advertisement, this issue

CHEMICAL ENGINEERS ARE DISCERNING PEOPLE

Discernment is as much a part of the chemical engineer's tool kit as his slide rule. He's forever deciding what's of value and what's window-dressing; what works, what doesn't. And Chemical Process Industries firms bet millions each year on his technical judgment.

THAT'S WHY

CHEMICAL ENGINEERING has more engineers on its publishing staff than all other Chemical Process Industries technical magazines put together.

THAT'S WHY

CHEMICAL ENGINEERING'S editors carefully screen and investigate each new product before reporting on it to you. This means no wasted time inquiring about old products or products that claim more than they can deliver.

THAT'S WHY

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THAT'S WHY

CHEMICAL ENGINEERING furnishes a complete allin-one-place informational service for the chemical engineer. The field's most extensive line-up of workoriented engineering articles, feature technical reports, vital cost information, news of technology, and practical engineering departments.

THAT'S WHY

In a recent magazine preference study in 29 leading Chemical Process Industry firms, CHEMICAL ENGI-NEERING received more than half again as many mentions as the next publication...more than 4 times as many "most helpful" votes...from men doing processing and engineering work.

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Published every other monday for Chemical Engineers in all functions,



AND OPPORTUNITY MAY MAKE A LOT OF DIFFERENCE TO YOU.

Why be the "Forgotten Man," the man who "waits for something better to come up," the man who "can't make up his mind?" Instead, step out from the crowd!

The time is NOW, the place is the National Lead Company of Ohio, meeting the challenge of atomic energy in a magnificent modern plant. And the door is open to you if you are skilled as a

- . PHYSICAL CHEMIST
- METALLURGIST
 CHEMICAL ENGINEER

For further information write the Employment Supervisor, Dept. J-107



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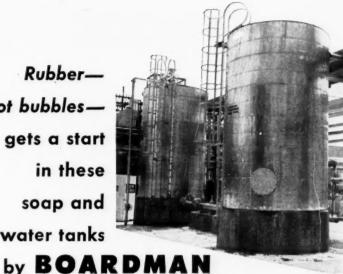
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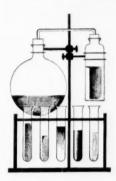
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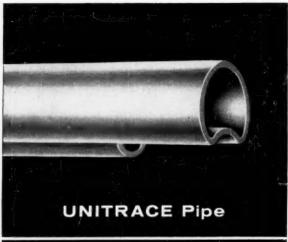
These 10,000-gallon tanks at the Port Neches, Texas plant of the Texas-U. S. Chemical Company contain the emulsifying agents used in manufacturing a superior, general purpose type of synthetic rubber. Each tank is 10'x17', and after installation, was jacketed with aluminum insulation. The BOARDMAN-built tanks were fabricated to the customer's exact specification.

Standard and custom-engineered metal products manufactured by BOARDMAN are in wide use throughout the chemical process industries. Metals employed include stainless steel, carbon and clad steels, wrought iron and aluminum. No matter how exacting the specifications may be for your metal products requirements, BOARDMAN's 7acre facilities and 46 years of experience are at your disposal.

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Users of steam-traced pipe have found that valuable savings in cost plus greatly improved efficiency are automatic when they use ALCOA® UNITRACE. It provides steam and product passages extruded in a single unit of light, strong, corrosion-resistant aluminum alloy...completely eliminating the need for costly external steam jackets or inefficient tracer tubes. Now a new flange and trace cap provide fittings and connections designed for UNITRACE which are compatible with conventional piping. You can now design completely integrated UNITRACE piping systems and get all these benefits:

Low heat loss...high internal heat transfer The recently introduced *round* configuration of UNI-TRACE makes possible most efficient internal heat transfer with minimum external radiation loss.

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The special UNITRACE Flange mates with all 150-lb ASA flanged connections, permits use of standard flanged valves or other flanged connections. And the new UNITRACE Trace Cap permits quick, easy assembly of cross or tee connections.

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The efficiency of UNITRACE often makes insulation unnecessary. When it is needed, standard preformed insulation can be used. UNITRACE saves extra dollars by employing smaller diameter insulation than conventional systems.

Excellent corrosion resistance

Thanks to the natural corrosion resistance of aluminum, UNITRACE is ideal for handling naval stores, molten sulfur, ammonium nitrate solutions, glacial acetic acid, fatty acids, tar, pitch, wax, urea, and similar products requiring heated transfer lines.

ALCOA UNITRACE and matching fittings are available in four standard pipe OD's: 1½", 2", 3" and 4". Get complete details on how you can use them to raise efficiency and lower cost on your own heated transfer lines. Call your nearest Alcoa sales office or write Aluminum Company of America, 903-F Alcoa Building, Pittsburgh 19, Pa.







We *make* a lot of Gearmotors here at Master. The point is, we've been *selling* more than all other makes combined. There are more Master Gearmotors in *use* than all others. Users *buy* more. And you don't find any foolish motor buyers—or not for long.

So it's obvious that Master Gearmotors simply must meet most requirements best. If you're not a Master Gearmotor user, now's the time to find out what you're missing!



Master Gearmotors are available with all Master motor types in right angle and parallel construction.

IT'S TIME YOUR DRIVE REQUIREMENT MEETS ITS MASTER

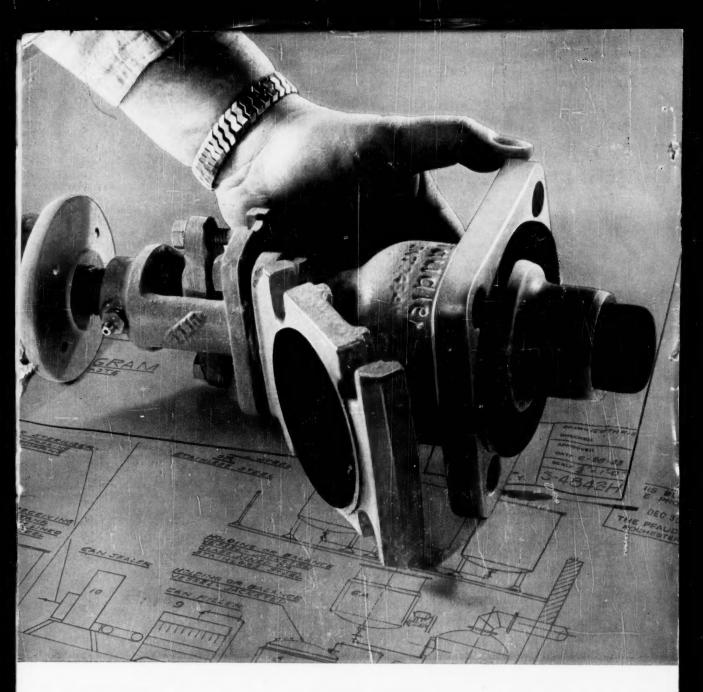
With five types of parallel and right angle Gearmotors, Master has the flexibility and choice of design you need.

With electric motor and gears combined into a compact, integral power unit, you reduce costs and increase efficiency through elimination of belts, couplings, chains, sprockets, external bearings or separate reducers.

They are available in sizes from ½ to 125 H.P. You can integrate with the gearmotor: electric brakes, 3 types of variable speed units and fluid drive in any combination.

THE MASTER ELECTRIC COMPANY . Dayton 1, Ohio

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Anything more you might want to know is covered in our Data Sheet 42. Write Dept. CEB-68 for a copy.

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